The
Geographical Journal.

No. 3. MARCH, 1896. Vol. VII.

MOVEMENTS OF THE EARTH'S CRUST.*

(Bradyseisms, Earthquakes, Diurnal Waves, Tremors.)

By JOHN MILNE, F.R.S., F.G.S.

When we reflect upon the attention devoted to the observation of heavenly bodies, the changes that take place in the atmosphere, and the tides and currents in seas and oceans, it seems remarkable that so little has been done for the study of the movements of the so-called *terra firma* on which we live, and in building foundations to carry instruments which measure and record phenomena which take place above and round about.

If we except earthquakes, which from time to time attract a momentary attention by their violence, the reason that the more universal movements which are in operation beneath our feet receive so little attention is probably that they are not appreciable to our feelings. We cannot see a coast-line sink or rise, but that such things have happened, and that they may yet be in operation, is a deduction based upon a variety of evidence. We do not see tall buildings slowly moving to and fro with a diurnal period; nor do we perceive by any of our senses that there are times when certain instruments behave as if the foundations on which they rested were spasmodically breathing. Although a physicist may tell us that on a certain day a change in level is in operation, our knowledge of this, like that of many other earth-movements, depends upon hearsay.

While saying something about earthquakes, the object of the following short paper is to indicate the character of movements which are either too slow or too small to note with our unaided senses, and to

* Paper read at the Royal Geographical Society, February 10, 1896.

point out the scientific and practical advantages which result from their study. We shall refer to them in the order of their relationship to each other—those with an orogenic origin, like bradyseisms and earthquakes, being taken first; whilst those like diurnal waves and tremors, the existence of which may depend upon meteorological conditions, are taken last.

Bradyseisms.

The first movements to be touched upon are the *slow* or bradyseismic motions of the Earth's crust which, relatively to sea-level, result in elevation or depression. The manner in which these are produced by a shell too weak to be self-supporting, folding and crumpling as it accommodates itself to a shrinking nucleus, is a theory sufficient to explain the existence of mountain ranges, the uplifting of strata which were once beneath the sea, and many of the more important features of the lithosphere. We shall treat of these movements in relation to continental development, geological history, and to what has been observed to occur during historical periods and a lifetime.

When studying the evidences we have of bradyseismal changes, the first inquiries relate to their magnitude, their form, and the rapidity with which they are performed.

As it is usually only the vertical component of these movements which is measured, and this relatively to ocean-level, a debatable point that presents itself relates to the fixity of this datum. We know that the oceans form a body of water always moving towards a position of equilibrium; that much has been written to show that by absorption a general lowering of level is in operation; that by sedimentation and the release of aqueous vapour from heated rocks, a movement in the opposite direction may be taking place; that by alterations in the position of the Earth's centre of attraction, and by other causes, there may have been changes in the configuration of the oceanic envelope. But putting these considerations on one side—partly because they result in long-continued uniformity of change in one direction—we may ask ourselves how far secular movements have resulted in real elevation or depression, and how far they are only apparent movements due to the rising or falling of the water.

The phenomenon we wish to consider is similar to that which takes place when we raise or lower an apple in a basin of water. When it is lowered the water rises, when it is raised the water falls, and the volume of the immersed solid is equal to the volume of the displaced fluid. If the rim of the basin was flat or saucer-like, over such a surface there would be large horizontal displacements of the water-line.

Applying such ideas to what may possibly have taken place during the growth of the habitable portion of the world—a great part of which we know was at one time beneath the surface of the waters—and

assuming that there was at some particular period in the world's history a universal, or nearly universal, ocean, if we have not considered the matter before, we reach a somewhat unexpected result. Because we know the volumes and areas of the oceans, and the areas and average heights of the continents above sea-level, if the latter have been raised above the former when it extended over the whole globe, then out of an apparent average elevation, usually estimated at about 1000 feet, 250 feet of this would be due to the recession of the waters. A measure of the *area* of existing land surface which may in this manner have been only apparently elevated, may be realized by noticing the area which would be covered if the present sea-level could be raised 250 feet.

Regarding the evolution of continental areas in this manner, we see that the retreat of the ocean may have played a part quite commensurable with that attributed to bradyseismical movement. Should we dismiss, as being improbable, the idea that at any period of continental development there has ever been an almost universal ocean, and only consider the elevations which have taken place within the range of geological history, we still see that secular movements have been accompanied by considerable changes in ocean-level, and still greater in ocean-area. In discussing this question, the *à priori* assumption is, that when any area rose above the waters, it is unlikely that there should have been at the same time, in some other region, a subsidence beneath the water, and even if such contemporaneous but opposite movements had an existence, it is still more unlikely that they should have been volumetrically equal. Granting this hypothesis, as an example of what is likely to have occurred at times well within the limits of the geological horizon, we may take the two great mountain-forming epochs in the world's history. About the close of the Palæozoic era, the Urals in Europe, the Himalayian-like Appelachians, and other mountain ranges were formed.

In early Tertiary times, the Alps, the Pyrenees, the Carpathians, and the Himalayas were growing upwards, whilst a series of islands were slowly uniting to form the Apennines and the Italian peninsula. The complexity of the folds and the faulted and contorted strata out of which these masses are built, taken in conjunction with the step-like arrangement of sea beaches and terraces, suggest the idea that processes of elevation are intermittent. As these mountains were slowly growing, relatively to the Earth's centre, certain tracts of the rocky crust would rise, others would fall, and there would be a universal contraction in oceanic areas.

With a ratio of land and water areas in early Tertiary times of 1 : 4, and a mean height of the mountains then elevated of 4000 feet, which is the present mean height of Switzerland, the vertical fall in ocean-level would be about 26 feet. This calculation of the fall in the waters

does not include that which would accompany the rise of the extended fold or dome on which the mountains stand, and the figure given is therefore probably much below the truth. The meaning of this retreat of the waters in relation to the history of oceanography is, that at the times when mountains were formed, an intermittent withdrawal of waters, which would be marked on shallow coasts, took place throughout the world, and extensive tracts would be bared, not by the rising of the land, but by the falling of the waters.

Although mountain ranges might, as they rose upwards, increase their distance from the Earth's centre, flanking regions, by approaching this centre at a greater rate than that at which the waters were falling, might be submerged. Accepting the idea of rapid sedimentation at certain points along these intermittently sinking coast-lines, and we have conditions for the accumulation of a series of strata such as are found in many coal-fields, and it is certainly remarkable that these two periods of mountain growth were closely coincident with two great periods of coal-formation. If we do not accept this suggested connection between mountain growth and the deposition of strata accompanying the occurrence of the formation of coal, not only have we to fall back upon the usual explanation that the coal-measures were formed when there was a nicely adjusted balance between the rate at which an area was depressed and the rate at which the same was rising by sedimentation, but we are left to explain why such an adjustment was only marked at two particular epochs in the Earth's history, and why it simultaneously occurred at so many points upon the surface of the globe, which, for carboniferous coal at least, lie between 20° and 60° N. lat. and 20° and 40° S. lat., in regions of bradyseismical action.

Although a relationship might be traced between pronounced secular movements, volcanic action, and other geological phenomena, the main object of the present section of these notes is to show that, although we may take sea-level as a datum relatively to which changes taking place within the historical period may be approximately measured, directly we attempt to measure the magnitude of upheavals with which the geologist has to deal, unless we make our datum at the Earth's centre, or at some fixed distance from the same, it seems possible that some of our results may exceed the truth by 25 per cent.

In Japan, as in many other countries, notably perhaps Italy, bradyseismical movements have, during historical times, taken place with great rapidity. With the assistance of Prof. D. Kikuchi, of the Imperial University of Japan, a few years ago, circulars were sent to officials at all the important seaports and villages round the coast, asking them to collect evidences whether, during recent times or within the memory of the oldest inhabitants, any changes had taken place in the relative positions of the sea or land. The replies, which were numerous, showed that, along the eastern side of the country in

particular, elevation had been in progress, this being particularly noticeable in districts where earthquakes were frequent.

Information gathered in this manner, taken in conjunction with the writer's repeated observations on sea-terraces, shell-borings in rocks well above high-water mark, and other appearances, it may be concluded that movements along certain portions of the Japanese coast have been exceedingly rapid—possibly an inch per year. At one point, where soft tuff rock projects into Yedo bay beneath the bluff at Yokohama, lines of shell-borings can be seen fully 10 feet above high-water mark. Because the rock is so friable and soft, it is difficult to suppose that these markings have been exposed to atmospheric influences for a length of time very much greater than fifty years. Be this as it may, the writer well remembers that nineteen years ago it was impossible to pass round a neighbouring point of similar rock, whilst now at low water it may be walked round, not over drift or shingle, but over a rocky surface. There are no reasons for supposing that these changes in the relative positions of land and water on the coast of Japan which are here referred to, have taken place suddenly. It must, therefore, be supposed that they have either been brought about by the gradual elevation of the land, or by the gradual withdrawal of the water. The Japan current, or Kuro Siwo, which flows up the eastern coast of Japan, and which is comparable with the Gulf Stream in the Atlantic, has, like other oceanic circulating systems, marked seasonal changes in its velocity, and the distance to which it is appreciable.

Although we have no definite data respecting the greater changes which may take place in the magnitude and velocity of ocean currents, owing to gradual but periodic changes in climatic conditions, possibly culminating in periods of glaciation, it is highly probable that such changes have an existence, and if they do exist, it is difficult to suppose that they have been unaccompanied by alterations in the general level of the oceans, and to some degree in variations in the amount of water held back in bays and estuaries, especially those which have narrow entrances.

Notwithstanding these considerations, the occurrence of earthquakes, the crumpled rocks intersected by numerous faults, and other phenomena, incline us to the belief that the eastern coast of Japan is growing in consequence of the movements of the rocky crust rather than by a recession of the waters.

Whether the measurement of these movements which bring about such rapid changes are phenomena of sufficient importance to attract the attention of harbour and other engineers, is a question that cannot be answered until they have been more accurately determined. The importance of forming a trustworthy estimate of the rate at which the larger folds of the Earth's surface have been formed, or by which mountains may be increased or decreased in height, is evident to all students of Earth physics.

The only experimental determinations of these changes are the well-known measurements which were made between marks cut upon certain rocks and sea-level in Sweden. The method, although apparently certain, has its objections. The fact that differences in level can only be observed after long intervals of time is in itself an objection, while the fact that during such intervals, by variations in ocean currents, by sedimentation, elevation or depression at the entrance to a closed sea, like the Baltic, along the shores of which the marks referred to were made, the play of the tides, relative to a phase of which the measurements must be taken, may have suffered alteration.

Results might possibly be obtained in a quicker and more certain manner by differential measurements of the records of three or more tide-gauges referred to neighbouring bench-marks. In a nearly closed bay, like that of Yedo, where the tide is small, it would be possible to choose times when tides had similar phases, and when we could assure ourselves that the surface of the water had the same configuration. Taking observations made at these times, although total rise relatively to a certain phase of tide may be measured, the chief determination would be the relative rising or falling of one point of land as compared with another, together with the axis of such a movement.

Several other methods of obtaining similar results suggest themselves, the simplest of all being the installation underground of several levels parallel and at right angles to the dip of strata. Under these conditions, where changes of temperature would be inappreciable, and where readings would only be required at long intervals, the ordinary spirit-level would be sufficient for the suggested purpose, but, to avoid effects due to the creeping of the soil, the levels should be placed upon the solid rock. With such an installation in Japan, where we know that movements are taking place with comparative rapidity, it is not unlikely that definite measurements of tilting could be obtained in a very few years.

From the observations of levels placed in a cellar, Plantamour has shown that there are long period displacements in the position of their bubbles. Astronomers observe slow changes taking place in solid masonry piers which carry telescopes, and von Rebeur-Paschwitz has recorded the wandering of the zero-point of his horizontal pendulums. In Japan it has been observed that two of these latter instruments, placed 1000 feet apart, have synchronized in the directions of their displacements, slowly creeping for ten or many more days in one direction, and then returning to travel past their starting-point in an opposite direction. Although these instruments may only show changes of 1 or 2 inches of elevation per mile, it is premature to assume that what has been recorded is due to secular changes in the inclination of the Earth's crust. Movements of this nature may be due to the gradual creeping of a layer of soil upon a slope, to the differential loading or removal of moisture on two sides of an observing-station, and possibly to other causes.

Therefore, until levels or horizontal pendulums have been established in duplicate in the suggested manner upon rock, we shall be unable to say that secular movement has been instrumentally measured or recorded.

Earthquakes.

To pass from movements which are accomplished so gently and so slowly that they are neither felt nor seen, to violent disturbances called earthquakes, which in a few seconds may alter the superficial aspect of a country, although the transition is rapid, it is one that is natural.

The greater number of earthquakes may be regarded as announcements that a resistance to secular movement has been overcome, and if such an explanation of earthquake origin is sufficient, then the relationship of the former to the latter is that of a child to its parent. Wherever we find mountains which are geologically young, where the process of rock-folding may yet be in progress, there we find earthquakes. Should these regions of rock-movement be near a sea or ocean, we also find volcanoes. Volcanic eruptions accompany the generation of steam and gaseous pressure beneath lines of yielding; while earthquakes, if we except a few explosive efforts at volcanic foci, tell us that rocky strata, bending under the influence of terrestrial contraction, have exceeded their elastic limit. Although both may occur in the same country, it is seldom that their origins are close together. In Japan it is seen that active volcanic vents chiefly occur along the backbone of the country which forms the upper edge of a huge monocline, whilst the earthquakes are most frequent on the flanks of this fold, or where it sweeps steeply downwards beneath the deep Pacific. The home of the majority of earthquakes is that of the majority of faults, which is a region of monoclinal folding. That a volcano by its eruption acts as a safety-valve for the surrounding district, does not seem to be borne out by observation. Earthquakes and volcanoes are independent, excepting in their parentage, and if between them there is a closer union, we should expect that a relief of pressure following an eruption would result in farther bending of the strata, and an increase in seismic frequency. If it is, therefore, admitted that the majority of earthquakes are the result of fracture resulting from excessive bending, rather than attempting to predict their occurrence by our sensations, the behaviour of lower animals, or the assumption of tides acting on lines of weakness beneath a hardened crust, a more reasonable method of procedure would be to determine whether the earthquakes of a given district are preceded by measurable changes in inclination of the yielding surface. During the last few years of the writer's residence in Japan, with the aid of delicately adjusted horizontal pendulums, some attempt was made towards the solution of such a problem. The results showed that in a number of instances there was an indication of a connection between a uniform and steady change in level and the occurrence of many disturbances.

Because the observations were incomplete, and because there were difficulties in separating earthquakes of a local origin from those which had originated at a distance, the definite solution of this problem remains for future investigations.

From the records obtained in Japan from nearly one thousand observing-stations, we learn that during a period of eight years about nine thousand distinct shocks were recorded, and for each of these the approximate origin and the area that was sensibly shaken have been determined. The analysis of a catalogue of these disturbances shows that Japan may be divided into at least fifteen distinct seismic districts, the records from each of which may be examined separately, the different shocks being taken as numerically equal or have values given to them bearing a relationship to the area which each disturbed. The records from each of these districts give relative measures of the rate at which rock-folding is in progress in such districts, and we are enabled to examine how far these changes are influenced by tidal loads, variations in barometrical pressure, and other phenomena exogenous to the crust of our Earth.

From the study of a series of *after-shocks* which have followed several large disturbances, Mr. Ōmori has shown that, in particular cases considered, the rate at which the broken-up strata settled to a state of equilibrium practically followed the same law, from which it may be concluded that the character of the disjointed materials had been on the average fairly similar. One result of these investigations is that, having observed for a month or so the number of *after-shocks* occurring in a given district, and in this way determined the first part of a curve of frequency, this curve may be completed, and from it we can see how many shocks we may expect in a given number of months, or how many years it will be before the district has returned to its normal state of seismic sensibility.

If we take the records *en bloc*, the only advantage which the Japanese catalogue of earthquakes presents over other lists is its completeness, and the fact that the different records can have "weights" assigned to them. By examining these records, we find that for Japan, as for other countries and for the earthquakes of the world, there is an annual and semi-annual periodicity, the former of which, as Dr. C. G. Knott and Mr. C. Davison point out, may be the result of differences in barometrical stress at two seasons of the year.

For very many of the shocks recorded in Japan, seismographs, writing on stationary or moving surfaces, have given diagrams from which we learn how many vibrations have constituted a given disturbance, the rapidity with which they have occurred, and the extent and direction of each successive movement. The study of these diagrams has led to the conclusion that earthquake-motion, which may be *felt* for periods varying between a few seconds and several minutes, is of

different types, and that each type has a signification. If, for example, we feel a long, easy, rolling motion, at which time the diagram is that of a series of slowly recurring waves, the inference is that the origin of the disturbance causing this movement is at a considerable distance. If, however, an earthquake commences with a series of small but rapid vibrations, followed by a shock or shocks, and irregular sharp motions which die away gradually, then the origin is near, and it appears that the difference in time between the commencement of the tremors and occurrence of the first decided motion is proportional to the distance of the origin from the observing station. The interval of time between the commencement of preliminary tremors and the more violent movements, as shown by an ordinary seismograph, when the distance between the observing-station and the origin of the disturbance is not more than 200 miles, seldom exceeds ten seconds; but if the movement has been propagated to a very long distance, the interval may be many minutes. Should, for example, an earthquake originating in Japan be sufficiently intense that, by means of specially contrived instruments of great sensibility to elastic vibrations and angular displacement, its movements can be recorded at places distant one quarter or more of the Earth's circumference, then it is seen that the tremors appear upon the diagram half an hour before the maximum phases of motion. These latter motions are propagated to these distant places at a rate of two or three kilometres per second, or at about the same rate as they are propagated to places relatively close to an origin. The former, however, assuming that they actually originated at the same time from the same origin as their larger followers, have been transmitted at rates three or four times as quickly, and it becomes difficult to suppose that they have passed through the heterogeneous materials constituting the Earth's crust. To make careful observations on the rate of propagation of these tremors, and to determine the paths they have followed, are two of the most important problems which the seismologist is now asked to solve. Their velocity is somewhat reduced if it is assumed that, instead of passing round our Earth, they pass in straight or curvilinear lines *through* the same; but even with this assumption, we find that the rate of transmission has been greater than it would be had our globe the same constitution as glass or steel.

Our knowledge of the interior of the Earth is at present chiefly based upon the revelations of the thermometer and the plumb-line. Whatever information these may have given us, it does not seem improbable that after a seismic survey has been established for our world, the records of seismographs may add definite information about the effective rigidity of our planet, which, from the little that has already been accomplished, seems to be very much higher than has usually been supposed.

Although many of the investigations relating to earthquakes have apparently only yielded results of value to those engaged in researches

of a purely scientific nature, yet a certain number of them have led to results of practical utility.

From the diagrams of earthquakes, the maximum velocity of a particle and the acceleration or suddenness of motions which are the destructive elements of earthquake movement resulting in projection, overturning, and shattering, have been calculated. That these quantities are real has been verified by numerous experiments, in which columns of brickwork and other bodies have been moved back and forth by a recorded motion, until, by the reaction of their own inertia, they have either been fractured or overturned. The result of these experiments and observations in the field has established the truth of calculations based upon diagrams, and if, after a destructive earthquake, we determine the amount of motion that has been experienced, either from the dimensions and nature of bodies which have been overturned, or from the records obtained from seismographs, we arrive at what are practically identical results. In the great earthquake which, on October 26, 1891, devastated Central Japan, at which time nearly ten thousand people lost their lives, the greatest accelerations recorded varied between 3000 and 4000 millimetres per second per second. Earthquakes which shatter chimneys, partially unroof houses, cause plaster to fall, and which give to an ordinarily built town the appearance that it might present after a bombardment, have a suddenness in their back and forth motions of about one-tenth of the above quantities. From these and other measurements, an engineer, having assumed that a certain quantity of motion may be expected, is now in a position not simply to make a structure strong because an earthquake is strong, but he is able to proportion and distribute his materials to exactly fulfil certain possible conditions. For example, in the building of piers to carry a railway bridge, we know from experience that, when they are sufficiently shaken, fracture first takes place at their base. This form of destruction is identical with that which occurs when a column of brickwork is placed upon a truck which can be moved back and forth at a continually increasing rate. At the same time it is in accordance with what we should expect, which expectations are borne out by the results of theoretical investigations. From observations and considerations like these, we see that walls, columns, and structures like piers and chimneys, require greater dimensions or strength near their base than those given to them in ordinary practice. Forms having equal strength at all their horizontal sections against the effects of horizontally applied motion have been designed; and in Japan, as illustration of these, we have the parabolic brick piers, some of which are 110 feet in height, designed by Mr. C. A. W. Pownall, M.INST.C.E., to carry the Usui railway.

One remarkable observation which seismographic records have confirmed and measured is the fact that, outside an epifocal area, earthquake waves like those of the ocean are somewhat greater on the surface than

they are at a comparatively small depth. The inference from this is, that a building rising from a basement 10 or 20 feet in depth, surrounded by an open area, will receive less motion than a building rising from the surface. Many large and important structures in Japan have therefore been built to rise freely from moderately deep foundations, and on more than one occasion it has been observed that they have not in the slightest degree suffered, whilst their near neighbours have been so far shattered that in certain instances they have required rebuilding.

These are by no means the only beneficial results which have followed seismic investigations. Rules have been formulated for the guidance of an engineer when selecting a site. The unadvisability of having undue top weight, or connecting together structures having differences in their natural periods of vibration, and many other principles to guide the practical builder, have been demonstrated, and it is pleasing to record the fact that the demonstrations have not been altogether unheeded, with the result that, in Japan at least, the security of life and property is greater than it was in former years. Seismometry has directly led to the construction of instruments which faithfully record the jolts and vibrations of railway trains, which show the magnitude and position of irregularities along a line. Modified forms of these contrivances give faithful representations of the jerking due to the want of balance in a locomotive, by correcting which the Imperial Government railways of Japan effect a considerable saving in fuel and repairs. Other instruments, also claiming the seismograph with its steady points as parent, are able to record the peculiar earthquake-like vibrations of bridges and the elastic movements of buildings and steamships.

Although seismology owes its present position to individual efforts made in many countries, standing foremost amongst which are the remarkable results achieved by the late Dr. E. von Rebeur-Paschwitz, a great impetus was given to this study by the establishment of the Seismological Society of Japan, which, during its short existence of hardly fifteen years, issued twenty volumes of original papers. The result obtained by this body of Japanese and European workers acted as an incentive to further investigations in many directions. In Europe seismographs took the place of seismoscopes, whilst the Imperial Government of Japan established a special bureau, which now controls nearly one thousand stations for the purpose of earthquake investigation, and endowed a chair of seismology at its university.

Diurnal Waves.

From movements the cause of which are to be sought in the crust of the Earth, we pass to others which are apparently more ubiquitous, and owe their existence to phenomena connected with our atmosphere.

In Germany and Teneriffe, diurnal waves have been recorded and

carefully analyzed by the late Dr. E. von Rebeur-Paschwitz. In Japan, photographic records of these displacements have been obtained at many stations.

The most pronounced movements correspond to a slow tilting of the instruments for ten or twelve hours towards the east, followed by a retrograde motion towards the west. Accompanying this there is a north and south component of motion, which is definite but relatively small.

Von Rebeur found, after a careful analysis of his records, that whatever may have been the chief cause of these displacements, which amount to three or four seconds of arc, but at certain stations in Japan to several times this amount, a slight superimposed lunar effect may be detected.

The records of these movements, like those of tremors and unfelt earthquakes, are obtained by continuously photographing on a moving film the varying position of a horizontal pendulum. When the pendulum remains at rest the diagram is a straight line, but if, during a period of twenty-four hours, it wanders slowly to the right and then back to the left of its normal position, the photogram is a wave-like curve, the amplitude of which varies according to the sensibility of the instrument and the locality where it is installed, from 1 or 2 up to 20 millimetres. In Japan, the localities where pendulums were installed were selected for the purpose of studying these movements under varying conditions. Five sets of diagrams were obtained from instruments placed upon the solid rock in caves, where the daily change in temperature and hygrometric conditions was barely appreciable. At these stations it was observed that the movements due to earthquakes were most pronounced in a direction parallel to the dip, suggesting the idea that this direction is that of least resistance, parallel to which there is a concertina-like yielding in the folded strata. Together with the displacements due to the diurnal wave, the pendulums showed that they slowly wandered, moving several days in one direction, and then returning towards their starting-point. Tremors and daily waves were not visible. Had the sensibility of the pendulums, which, in the experiments in Japan, never exceeded a displacement on the film of 1 millimetre for an angular tilting of 0·1″, been greater, it is possible that the latter phenomena might have been observed. In Europe similar or corresponding instruments have had sensibilities given to them of 0·01″ to 0·003″. The latter degree of sensibility means that changes in inclination of 1 inch in about 1000 miles would be measurable.

Another station was in an underground chamber in the alluvium, where the daily changes in temperature, as in the caves, was extremely small, but where, in consequence of fairly good ventilation, there may have been considerable changes in hygrometric conditions. The depth of this chamber was 12 feet. The records showed wandering of the

pendulums, tremors, and daily waves, all of which were at times quite as pronounced as they were at stations on the surface.

These latter records lead us to the conclusion that diurnal waves are not to be attributed to the immediate effects of any change in temperature close to the instruments.

The remaining stations, where the instruments stood on brick columns with concrete beds, were on the alluvium, which near Tokio forms a layer of reddish stiff soil 50 to 100 feet in thickness, above a soft grey clay-like tuff rock. A locality at which the diurnal wave was hardly appreciable was in a wood. At this place there were high trees for some distance all round the hut in which the pendulum was placed, which protected it from the direct effects of the sun. On an open plain, where on one side of the station there was ploughed ground and on the others green corn, the movements were slight but fairly regular. They apparently indicated that during each day the ground covered with corn rose relatively to that which was bare. At all the other stations where the ground was covered with trees or buildings more upon one side than upon the other, the daily waves were large, and often differed in phase. For example, on two plateaux on the two sides of an open swampy valley, the instrument on one side of this having a protected area on its east side, and those on the other side a somewhat similar area on the west, moved at the same time in opposite directions—that is to say, if the trees on these two opposite scarps followed the movements of the instruments, it may be concluded that on each fine day they bowed towards each other.

A very important observation made at many stations was that *on wet and cloudy days diurnal waves were absent.*

The general conclusions to which the various observations point, is that the movements which take place during the day are due to the removal of a load from the side of the station most exposed to the effects of radiation, and in the alluvium this effect is quite pronounced to a depth of at least 12 feet. This load may be represented by aqueous vapour carried upwards and then dissipated.

On a fine day experiment shows that from moist open ground as much as one ton of moisture may be removed from an area 20 yards square. If an action of this sort is more marked upon one side of an instrument than upon another, then the ground by its resilience rises on the former side, and the pendulum swings away from the area which has been most relieved. In a similar manner, a load composed of men and boys marched up to one side of the station causes the ground on that side to sink, and the movement of the pendulum is towards the loaded side; when they retire, the pendulum returns to its normal position. For reasons like these, the instruments on the two opposite plateaux during the day move in opposite directions, or away from the intervening open valley, where unloading is most marked; while an

instrument on uniformly exposed ground or in a wood shows but little or no motion. That there is little or no motion during rainy or cloudy weather, is evidently due to the fact that at such times there is but little evaporation.

A desirable experiment would be to record the movements of a horizontal pendulum on a uniform and equally exposed prairie-like plain. In this case, because during the morning the sun would take away more moisture from the east than from the west side of the pendulum, until noon or about two in the afternoon, we should expect to find the motion westwards. After a pause, some time in the afternoon, a retrograde movement would set in and continue until some time after sunset, but both movements would be small.

From this we see that a pendulum which has been moving westwards may have the direction of its motion reversed; but the difficulty which presents itself is to explain the manner in which this retrograde motion, having been established, continues during the night, until it nearly returns to the position it had on the previous morning. The explanation of this phenomenon apparently rests on the fact that during the night the area which during the day has lost the greatest load may be the one which gains the greatest load. The establishment of this suggestion depends upon facts and experiments relating to the precipitation and condensation of aqueous vapour. On open ground where radiation is marked, there is a greater precipitation of moisture in the form of dew than there is upon ground which is protected by trees, buildings, or other coverings. The quantity of moisture which is in this way drawn from the atmosphere, or, as Aitken has shown, is trapped just as it rises from the ground, is however small, and cannot be taken as more than one-eighth of that which during the day has been moved by evaporation. Although it may assist in causing the reloading for which we seek, by itself it is insufficient to explain all that is observed; and, further, the retrograde motion of a pendulum may have taken place on nights when dew is not observable. On such occasions, however, a differential loading of two neighbouring areas may have been brought about either by the condensation of moisture on the immediate surface of the ground, beneath leaves and stones, or actually beneath but near to the surface.

If we look beneath a board which has been lying all night upon the grass, it does not unfrequently happen that its under side is wet with moisture, although the grass around may be dry. This observation suggested the idea that just as moisture is condensed beneath a board, a leaf, or a stone, so it may be condensed *in* the ground, within one or two inches of the actual surface. On a hot day moisture is evaporated from soil, and this is perceptibly heated to a depth of about a foot. Shortly after sunset the surface to a depth of one or two inches is chilled, or in winter it may be frozen. The result of this is that

moisture rising as vapour, and by capillarity from water-bearing strata below, is condensed on the under side of the chilled surface. To determine how far superficial soils gain in weight by an action of this description, independently of moisture precipitated from the atmosphere, or condensed as it rises from the ground, the following experiments were made.

Two boxes, each 1 foot 6 inches square, and about 2 inches in depth, were balanced on the extremities of beams carried upon knife-edges. One box had a bottom made of tin, and the other of fine wire netting, and each was filled with earth. Excepting when these were weighed by hanging weights at the other extremities of the beams, they were allowed to rest upon a bed of soft earth. Sometimes it was found that during a night both of the boxes would lose weight, but at other times it was found that the weight of the box with the tin bottom had not changed, whilst the one with the wire netting had gained from 2 to 2·5 ounces, which apparently showed that there had been a condensation of moisture coming up from beneath of 10 ounces per square yard, or about one-eighth of that which had been removed during the day by evaporation.*

Although the retrograde motion of a pendulum during the night is usually less than that which had taken place during the day, thereby causing a creeping of the zero point away from an area of rapid evaporation, the question is whether the precipitation and the forms of condensation which take place between sunset and sunrise are sufficient to produce the observed effects. Our data respecting sub-surface condensation are unfortunately confined to the few observations made by the writer, and many observations have yet to be made before its quantitative analysis has been completed. The greatest effect would be produced when each of these forms of condensation was at a maximum and acted in conjunction.

The difference in the weight of moisture evaporated from two neighbouring areas is apparently sufficient to cause the movements observed during the daytime, whilst the difference in the weights added to such areas from a water-supply common to each, is a phenomenon which may influence the movements observed at night.

These explanations, although they may be sufficient to account for many of the movements observed in Japan, because instances occur where their application is not clear, until they have received more careful attention, can only be received as provisional. At Potsdam, for example,

* In consequence of a fire which occurred at the writer's house, not only were the notes relating to these experiments destroyed, but the experiments themselves had to be terminated. Sub-surface precipitation is evidently closely related to a fact noticed by farmers upon the chalk downs in the Isle of Wight, who find that if the ground is cleared of flints, which means the depriving it of its radiators and condensers, its fertility is impaired.

where Dr. E. von Rebeur-Paschwitz tells me that the ground is equally covered with trees towards the east and west, the motions are quite pronounced, and the same authority has observed extraordinarily large motions on a strongly founded pillar, when there was apparently no motion in its neighbourhood.

An experiment which has yet to be made is to place an instrument upon a pillar, the two sides of which are unequally porous, with the object of determining whether any of the observed movements, especially tremors, which are described in the next section, can be traced to changes taking place in the supporting column.

NOTE.—From the researches of S. H. Miller, F.R.A.S. (Prize Essay on Evaporation, published by the Utrecht Society of Arts and Sciences, 1878), it would appear that the average daily quantities of evaporation for *particular* months are approximately as follows:—

Soil (humus; July)	4,243	lbs. per	sq. yd.
Water (July, 1869)	8,613	,,	,,
Forest (a spruce)	12,528	,,	,,
Grass (red clover; May)	15,613	,,	,,

These loads, which are removed during twelve hours of daylight, may be either greater or less than the quantities given. They are practically in the ratio of 1 : 2 : 3 : 4.

The greatest daylight displacement of a horizontal pendulum ought, therefore, to be expected when such an instrument was placed on the boundaries of two areas respectively covered with soil and grass. On a fine day the differential evaporation effect on the two sides of the instrument would be equivalent to removing a load of about 2½ tons per 20 yards square from the ground covered with grass, which is quite sufficient to produce many of the observed effects.

EARTH-TREMORS.

The last class of earth-movements to which we have to refer are even more perplexing, and more frequently observed than the diurnal waves.

These are the earth-tremors, earth-pulsations, or microseismic motions, which were first systematically observed by Father Timoteo Bertelli of Florence. The method that Bertelli adopted prior to 1870—which was to observe, by means of a microscope, the movements of the style of a pendulum carefully sheltered from air-currents—is practically identical with the methods yet employed at very many stations throughout the Italian peninsula.

Amongst the more important results obtained by these observers, and confirmed by observations made in other countries, is that tremors were more frequent in winter than in summer, and when the barometer is low rather than when it is high.

In Japan during the last nineteen years these movements have been

studied by the use of a large variety of instruments, whilst for some years past the records have, by photographic or other means, been made continuous.

The analyses of a long series of these latter records have shown that tremors were usually at a maximum when the barometric gradient was steep, no matter whether, at the place where they were observed, the barometer was high or whether it was low. From this it may be concluded that when tremors are pronounced, somewhere or other, either at or within 100 or 200 miles distant from the point of observation, a strong wind may be blowing. This conclusion, which has been verified by an appeal to weather charts, led the writer at one time to regard local or distant winds as the immediate cause of microseismic storms. Although the mechanical action of wind upon buildings, trees, and the surface of the country may produce slight tremors and influence the character of a record, the fact that tremors are sometimes observed at the time of a dead calm around the station, and that they may not be visible when the building in which the instrument which renders them visible is being violently shaken during a heavy storm, has led observers to think that tremors are not the immediate effects of wind. The reason for the existence of tremors was next sought for in fluctuations in barometric pressure. During a typhoon the needle of an aneroid may be observed to pulsate back and forth, whilst the slow change in pressure over an area may, as von Rebeur has shown, produce sufficient alteration in level to be recorded by movements of a horizontal pendulum. When barometrical pressure is changing rapidly over a district, the parts of which offer different degrees of resistance to distortional effects due to varying pressure, the inference is, that such a district might be thrown into a state of irregular agitation sufficiently pronounced to cause the movements called tremors. Although tremors may perhaps be induced by causes such as these, and therefore be really the result of actual movement of the ground, a close inspection of photograms, and a knowledge of the localities where they were obtained and the character of the instrument which yielded the records, give rise to a suspicion that some of these intruders, which may mask effects due to distant earthquakes, and interfere with many delicate physical operations, are, in some cases at least, the result of movements of the atmosphere.

The instruments in the caves, where it was uniformly damp, and many of those situated in huts upon the surface, where the ventilation was so good that it was difficult to understand why the long booms of the horizontal pendulum had not been set in motion by currents of air, either never showed a trace of these movements, or, if they were shown, they were insignificantly small. With other instruments, some of which were well protected inside substantial buildings, and the possibility of their being affected by currents of air from the outside was

inconceivable, day after day tremors were pronounced. The difference between these two sets of installations was, that the pendulums showing tremors were either longer in proportion to their weight, or actually very much lighter than those which remained steady; and experiments showed that the smaller and lighter a pendulum was, the more closely it approached in character to the imaginary instrument endowed with perpetual motion. The conclusion derived from this observation was, that the so-called Earth-tremors might in some way or other be due to air-currents produced within the containing cases; but there was nothing making it likely that such currents were due to any marked difference in temperature between the parts of an instrument and its enclosing walls.

An experiment which tended to confirm this view was to place a tray of calcium chloride inside the case containing a horizontal pendulum, when it was observed that the pendulum commenced to swing. The meaning of this is that air-currents are produced by rapid desiccation, which is a cause of atmospheric circulation, which has a wide application, but which is seldom emphasized.

Assuming this explanation for the origin of *certain* so-called Earth-tremors to be correct, great difficulties occur when we attempt to explain the peculiarities they exhibit in the times of their occurrence.

If a tremor-storm extends for several days, it is noticed that maxima of movement occur during the night, or from 9 p.m. until 6 a.m. As the disturbance dies out, tremors will only be observed at these hours, until finally the disturbance will end with a little movement about 6 a.m. Some instruments have only shown movements about daybreak, whilst one showing a maximum motion about this time was always on the swing at night (Fig. 9). It will be observed, therefore, that tremors are frequent during the time that the portion of the diurnal wave is most gentle, and that the maximum of tremors occurs about the time when the reversal in the direction of the diurnal swing of a pendulum takes place. Although experiment has shown that the appearance of tremors can be produced by the removal of a heavy load at the distance of 100 feet from a pendulum, at which time it slowly heels over towards the relieved area, because they are often frequent when no daily wave is observable, it does not seem likely that there is any direct connection between these two phenomena.

The conclusion at which we therefore arrive is, that during the night, and especially about daybreak, in consequence of the absorption or giving-off of moisture within more or less closed cases, and possibly to a greater extent outside them, air-currents are produced which are sufficient to move light pendulums, and that some of these movements have been supposed to be caused by an actual movement of the ground.

By no means can all tremors be explained in this simple manner. For example, the horizontal pendulum, now working at Shide, which is

usually adjusted to have a period of seventeen seconds, often shows tremors extending over many hours, which have periods of from one to three minutes. It may be possible that air-currents have produced these movements, the character of which indicates a slow tilting of the instrument; but it seems unlikely, especially when it is seen that for several hours there has been no variation in the period or amplitude of the displacements (Fig. 7). The bulk of tremors seem to have their origin in causes which are meteorological; but we are yet waiting for a more complete explanation of the manner in which they originate.

Although we see in diurnal waves and tremors the results of meteorological phenomena which affect agriculture and forestry, the movements they represent usually present themselves as intruders which have not simply interfered with, but which have hopelessly destroyed certain physical operations.

Tremors brought investigations relating to lunar gravitation at Cambridge to an end; tremors may have been the cause of unsteadiness of images from long focal lenses, rendering accurate astronomical photography uncertain. Times have occurred, when making determinations of standard weights, that balances have been unsteady; and the writer has repeatedly observed delicate forms of these instruments, used in assay work, on the swing and often changing their zero-point. How far tremors may have accelerated or retarded the swing of pendulums in gravitational observations, we do not know. What we immediately wish to do in regard to tremors and diurnal waves is to find means to isolate ourselves from, or at least to minimize, their effects. We can entrench ourselves against the mechanical vibrations of a passing train by means of trenches, and the surveyor in a city can isolate his instrument against the same intruders by a suspension of rubber bands.

How far the study of the tremors which have here been described will enable us to avoid their effects or to destroy them, or to what extent a closer examination of these ill-understood phenomena will prove beneficial, are matters only to be decided after further investigation.

Before the reading of the paper, the PRESIDENT made the following remarks: The paper this evening, which we may expect to be of an extremely interesting and novel character, is by Professor Milne, on the movements of the Earth's crust. I will now call upon Professor Milne to read his paper.

After the reading of the paper, the following discussion took place:—

Sir ARCHIBALD GEIKIE: I think the Geographical Society is to be congratulated on having had from our great authority on earthquakes so luminous and so humorous a description of the subject as he has given to-night. I don't know whether it is a fortunate thing to live in an earthquake country, but Professor Milne's residence of many years in Japan has given him experience of more earthquakes than any other man of science in the world has had, and he has certainly devoted more time to the study of them. But not only has he given attention to

earthquakes, he has, in recent years, been studying the minute and almost imperceptible movements which Mother Earth is continually suffering. From the point of view of Geography, we ought specially to support the idea of having these movements carefully measured. The day for the kind of observations which were all that Mallet and his predecessors had to rely on, is past; we can get no more information as to the internal economy of the Earth from that source. What we want now is careful and critical measurement to explain the movements of the Earth's crust. The fitting up of ten or fifteen observatories would probably not cost very much, and even if, in two years, we could get only a part of what he has promised us, I think the expense would be well bestowed. There are various features of physical geography where such measurements might help us. "Old as the hills" is a familiar phrase, but the hills differ vastly in age, and many of them are growing still. We do not know the rate of their growth, but if we had such observatories fixed up, we might be able to watch from year to year the gradual movement, either upwards or downwards, of a mountain chain. Then, again, we know almost nothing of the source of earthquakes. Professor Milne, though familiar with many of their phenomena, has not yet been able to throw much light on their actual source. No doubt they arise from many causes, and possibly the instrument to which he has referred may enable him to classify the various earthquakes and say that they originated, some from one, some from another cause. These are some of the geographical aspects of the subject which he has brought before us. I rejoice very much to have listened to him. He and I have corresponded for many years, but it is not often I have had an opportunity of seeing him in the flesh. He has set up an observatory in the Isle of Wight, where he sits watching for earthquakes in all parts of the globe, and recording the tremors that affect the ground. I think it is incumbent on geographers to do everything they can to further the institution of similar carefully equipped observatories for the detection and recording of these earth-movements. We can never tell to what practical account the most abstract scientific research may be turned, and I think we can even now see, apart altogether from the scientific results, the practical bearing of some of these observations. I hope the idea will be taken up and developed.

Dr. H. Woodward: I don't think, after we have heard Sir Archibald Geikie, that it would be proper that I should add any remarks, except to congratulate my friend, Professor Milne, on his return to England after twenty years' residence in Japan. When a man has been working steadily in a foreign country for twenty years, he must feel it a great pleasure to come back and meet with a large and appreciative audience like the present one, to take an interest in the work he has been carrying on, when one considers the very small encouragement one receives in a foreign country; and although we have not as many earthquakes to supply him with, yet, if what he has told us to-night is to be relied upon, that he can receive through the Earth, from all parts of the Earth, earth-tremors and indications of earthquakes, and can measure them, it is hardly necessary he should go further away. At the same time I hope, for the peace and safety of our island, as Sir Archibald said, that he will not promote the production of too many earthquakes here. I hope the Society will encourage Professor Milne in every possible way, and help him in setting up proper stations to make observations, and when these are accumulated we may look for most valuable results. Nothing can be more striking than what he has pointed out regarding the rapidity with which earthquake-tremors are transmitted through the centre and different portions of the Earth's interior, because it would seem to point out an enormous density of the Earth's interior as compared with what we had reason to suppose would be the case, and if that is so, it may lead to most important results with regard to a knowledge of the interior of the Earth, which we

can never hope to reach by any other means. I heartily congratulate Professor Milne on his interesting paper.

Professor JOHN PERRY: I am afraid I am not well able to respond to a sudden call like this. Indeed, as Professor Milne hinted in his lecture, I have not anything to say even about the instrument which I invented. I may further say that even in my three and a half years' stay in Japan, I was not able to develop any greater love for earthquakes or for the study of earth-movements than exists in the average inhabitant. But I can admire the enthusiasm, and I can welcome results of the work, of a man like Professor Milne. I confess that I have puzzled very uselessly over that fact so wonderful to the mathematician, that earth-ripples travel sometimes from Japan to Europe at the rate of 12 to 20 kilomètres per second. As a practical engineer, I take it that the most important outcome of Professor Milne's work during twenty years is that he really has discovered how to protect houses from earthquakes. He has not said anything to us about this to-night, but it is a very wonderful thing. To me, living as an engineer in London, the interest in this matter greatly depends upon the possibility of mutual reversibility of the problem and its solution. He isolates a house so that it cannot be affected by motions of the outside earth. Can we employ Milne's method to so isolate an engine that it cannot give motion to the outside earth? I feel sure that we can, and if this is the case, one great trouble will be removed from the minds of electric light engineers. It was in connection with this great trouble that I recently began to study the subject of earth-movement. The instrument which Professor Milne has shown you was hurriedly designed to allow me to make observations of motions in a block of houses built near an electric light station. I have been able to discriminate between up and down, north and south, east and west motions, and to observe their amounts. Professor Milne applies it, I think, to indicate more particularly, changes of inclination. He has assisted me by using one of his horizontal pendulums to make actual records of the motions in my block of houses. I congratulate the members of this Society on hearing such an excellent lecture on the subject of earth-movements from the man who has so specially made it the study of his life, and I hope that he will be successful in establishing his seismic observatories at many places over the world.

The PRESIDENT: It is from Sir Henry Howorth that we must hope for the advocacy of the cause of establishing observatories in England. As there are 928 in Japan, our Government might respond to our request for one here, and we must look to Sir Henry Howorth, one of the scientific members of the House of Commons, to help us in advocating this measure.

Sir HENRY H. HOWORTH: Whatever courage it may require to face these awful earthquakes in Japan, you must attribute to me a considerable amount of courage in daring to get up on the eve of Parliament, to make a suggestion that the money which is wanted for guns and ironclads should be invaded by a claim for observatories to record various methods of earthquake action. You will be pleased to know that, so far as I am concerned, it will be a great delight to press on this kind of expenditure; for, in addition to believing that we cannot spend too much in insuring what we have, I want to make what we have as good as we can, so that we may be at the head of all nations, if possible, in science as well as material prosperity, and not have a rival in our Japanese friends in investigating earthquakes. But I must remind you, sir, I belong to a class not popular in the House of Commons—the independent member, and the independent member is described as "a rascal, whom no party would trust," and therefore all I can do is of very little value and importance. May I refer to one kind of earthquake that happens in England, to which my friend did not refer. We have to welcome here

to-night, not only Mr. Milne himself, but the lady who has shared all these perils with him, and I am pleased to believe that there are certain tremors and earthquakes that occur in a good many houses in this country, even in the houses of members of Parliament, which do not reach Japan at all, and these he will hardly be able to measure by the instruments on the table. I refer to domestic tremors. I believe I have one curious distinction in this room. I was born in the house which was situated in the very middle of where the great chasm took place in Lisbon, in the year 1755, in the corner house of Blackhorse Square, built by the Portuguese king over the spot where the collapse took place. This I have often seen as a boy, for the remains were not removed until three-parts of a century afterwards. One moral that we should draw is this, that we never know when these paroxysmal movements take place, or in what particular quarter. People do not realize that the destruction of the Eastern empire was more by earthquakes, that destroyed nearly every town in Asia Minor, than any other thing in the world, and those earthquakes that came in a great rush in a certain period of Byzantine history, might come, it appears to me, with a rush in any latitude, because we do not know the laws which govern the distribution of these movements. It would be a great gain to us if we could analyze how these forces are moving, and in which direction, for we may ourselves have to face some of these perils presently; but, apart from this there is the greater question which really underlies a great deal of the reasonings in the sciences of geology and terrestrial physics. It is important, as my friend on my left—who has written the most delightful book on the physiography of the Earth I know anywhere, the 'Scenery of Scotland'—has said, that when we study these sciences, the causes of earthquakes and their effects form the very elementary knowledge we must have, if we are to understand these problems. The whole of science is continuous; we know now that all the gases, liquids, and solids are perfectly continuous forms of matter. These waves of motion, which were supposed formerly to be limited to air and water, pass through solid ground as easily as through liquid masses. We shall now be able, because we can apply our tests more easily through solid matter, to test the character and extent and work of this kind of earth-movement. I must ask your indulgence for detaining you so long, but the lecture has been most delightful in every way, and I cannot say how much we all appreciate the difficulty of introducing a little humour into a dry subject, which seismology at first sight seems to be. We hope we may be able to secure one or two at least of these most necessary observatories in this country.

The PRESIDENT: I cannot help recurring to the time, many years ago, when this study of seismology was confined almost entirely to earthquakes. I was looking the other day over one of the addresses of my illustrious predecessor, Sir Roderick Murchison, delivered in 1859, and I found that he referred to the subject of the lecture to which we have been listening this evening. He said that "the theory of earthquakes could only be regarded as a subordinate part of a more general theory which will deal with all earth-movements, great or small, to which the Earth's crust is subject." He looked forward to the time when an attempt would be made to unite into a whole the mass of facts, and to account for them by the application of one consistent theory. Now, I think this shows rare prescience in Sir Roderick. He almost seems to have foretold that we should have such a meeting, and listen to such an address as we have heard this evening, looking forward for a period of thirty-seven years. I think I may assure Professor Milne, on the part of the Council of the Royal Geographical Society, that he will receive all possible help, and that the Council will use all the influence it possesses in order to further the admirable work of establishing these stations in proper places over the globe. It now only remains for us to perform the very

agreeable task of thanking Professor Milne for combining, with amusement and humour, an address which is likely to be an important starting-point in a new direction, and in a new line of investigation, or, at all events, a very great enlargement of a former line of investigation. It is quite clear that, however dull the subject—and seismology is certainly not a dull subject—it would never be dull in the hands of Professor Milne. Now I ask you to return Professor Milne our warmest thanks for the very interesting evening he has given us. Our next meeting is on February 24, when Mr. Littledale will read an account of his recent very interesting journey through Tibet. I cannot help, in anticipation, expressing my admiration of the way in which Mr. Littledale performed his journey. Mr. Scharbau has put into my hands a note, by which I see that, after going over 860 miles by dead reckoning, he was out only half a mile when he came to fix his position by the observation.

APPENDIX.

For the purpose of making the references to the records obtained from seismographs and horizontal pendulums more clear, it has been thought advisable to add the following diagrams.

A. *Records from Seismographs.*

Fig. 1.—This figure shows the vibrations of an earthquake (September 3, 1887) as recorded upon a *stationary* smoked glass plate. From this we see that, although the greatest movements have been in a north-east and south-west direction, movement has taken place in many azimuths. The direction followed by an earth-particle

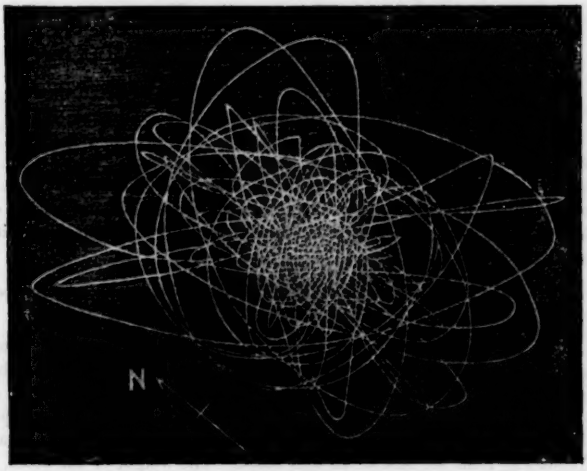


Fig. 1.

has not been in straight lines, but in ellipses and along paths showing a complexity of curves.

Fig. 2.—The diagrams shown in this figure are those of the north-south and the east-west components of an earthquake recorded upon a *moving* smoked glass surface. The vertical component is not shown. A portion of the preliminary

tremors are shown preceding the large vibration or shock of the disturbance, which is followed by irregular vibrations and jolts, which in some earthquakes may continue for several minutes. Small vibrations corresponding in period to the preliminary motions are often superimposed upon the latter portion of a diagram, which usually dies out as long-period smooth undulations. Although this diagram illustrates various types of earthquake motion, it is only occasionally that all occur together. Instead of one shock there may be several shocks, or a movement

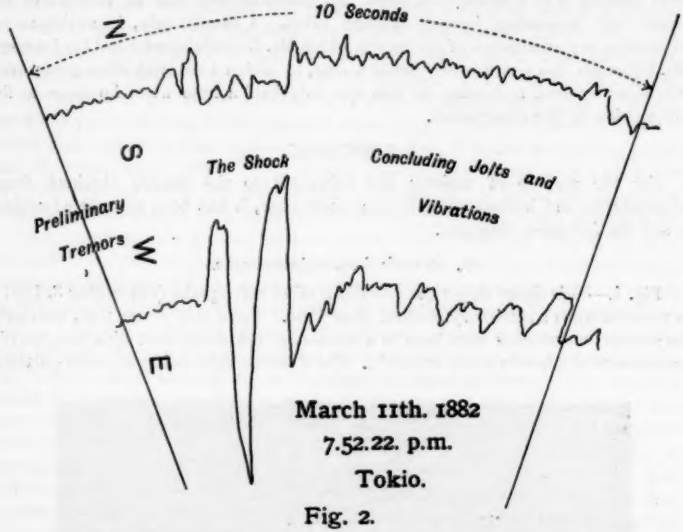


Fig. 2.

consisting only of rapid vibrations or of gentle undulations. The duration of the disturbance as recorded by a free horizontal pendulum may be several hours.

From the open diagrams, it is evident that the amplitude and period of any vibration may be measured, and from these quantities maximum velocities or or accelerations may be calculated.

B. *Horizontal Pendulums intended to record Earthquakes, including those which cannot be felt, Diurnal Waves, Tremors, and other Earth-Movements.*

Fig. 3.—This figure shows the chief features of a horizontal pendulum standing on a masonry column, with the photographic recording apparatus on a table at a lower level, which is an arrangement found to be convenient. The boom of the pendulum, which is about 2 feet 6 inches in length, is held in a horizontal position by a wire tie, which brings the agate pivot at the inner end of the boom against a needle projecting from the base of an iron stand. The weight of the boom, which is made of aluminium, is balanced by two small weights at the extremities of a small bar pivoted between the tie and the stand. The stand has three levelling-screws. The front one of these tilts the boom in a fore and aft direction, thus varying the sensibility of the instrument. Another of these screws has a pointer moving over a scale of degrees. By turning this screw the plane of the stand and boom may be tilted through a known angle. This results in the outer end of the boom being deflected through a certain number of millimetres. The instrument

is usually adjusted so that the period of its swing is about seventeen seconds. When this is done, a movement of the outer end of the boom of one millimetre indicates that the stand has been tilted 0·5″ of arc.

The outer end of the boom carries a small slip of blackened mica, which has a

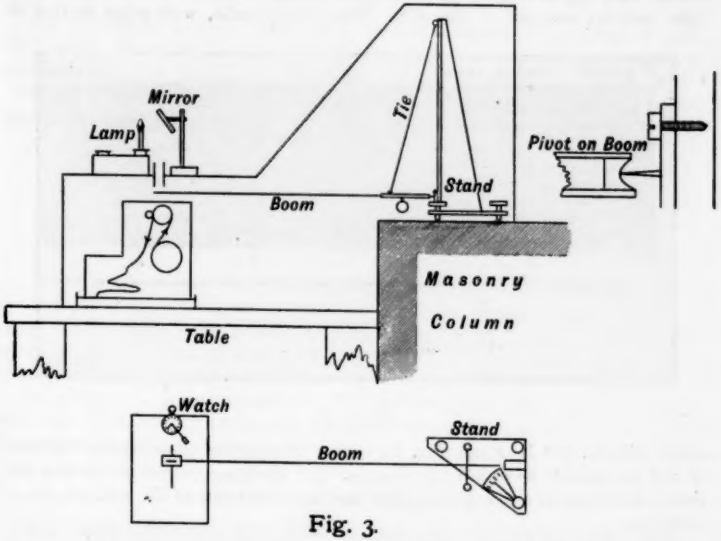


Fig. 3.

slit in it. This floats over a slit in the lid of a box, which is at right angles to the slit in the mica. In the box there is clockwork driving a 2-inch band of bromide paper. The light from a small benzine lamp is reflected by means of a

Fig. 4.

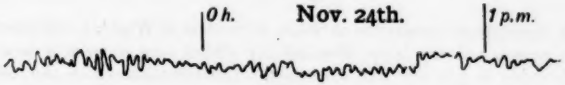


Fig. 5.

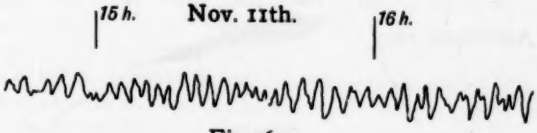


Fig. 6.

mirror downwards through the two slits, and reaches the paper as a point. If the floating plate has a broad slit and a narrow slit, the image on the moving photographic surface is that of a broad line and a fine line (Figs. 4 and 7). The

fine line gives beautiful definition for slow movements, whilst the broad line is visible for rapid motions when sufficient light may not have passed the fine slit to make a photographic impression.

The rate at which the paper moves is controlled by a watch with a long minute-hand tipped with a piece of blackened mica, which every hour eclipses the light entering one end of the slit. These hour-marks, with paper moving at

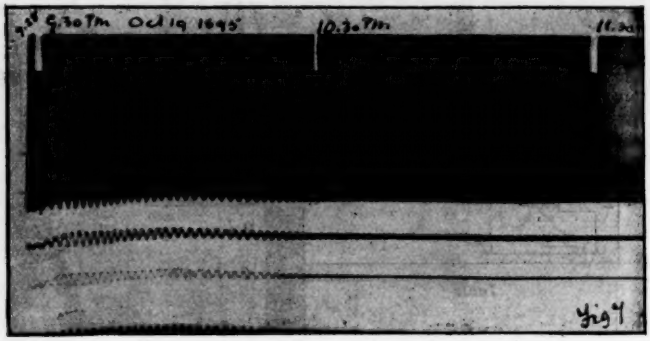


Fig. 7.

about 45 mm. *per hour* (see Fig. 7), enable an observer to determine the time of any movements to within ten seconds. For studying diurnal waves and the times when tremors are frequent, paper moving at the rate of 75 mm. *per day* is sufficient.

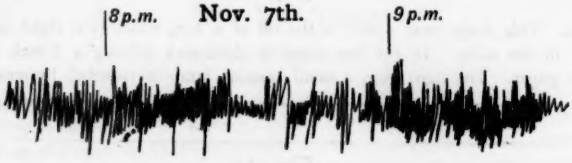


Fig. 8.

With the writer's installation at Shide, in the Isle of Wight, every morning the watch is wound, and the lamp attended to; whilst once a week a new 25-foot roll of bromide is put into the clock-box. The attention which the instrument

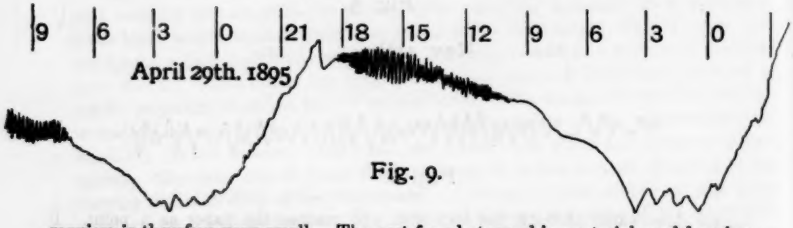


Fig. 9.

requires is therefore very small. The cost for photographic materials and benzine is about two shillings per week.

Fig. 5.—Shows small long-period irregular tremors.

Fig. 6.—Shows large long-period irregular tremors.

Fig. 7.—Shows tremors with great regularity in period and amplitude. This is a photographic reproduction of the photographic record.

Fig. 8.—Shows rapidly recurring tremors, which sometimes continue for several days.

Fig. 9.—Shows a daily wave, with tremors between 9 p.m. and 6 a.m. (18 hours). These waves may be larger or smaller in amplitude, and have a smooth outline.

Fig. 10.—This shows an earthquake recorded in Japan, which had its origin *near to the antipodes* of that country in the Argentine Republic on October 27,

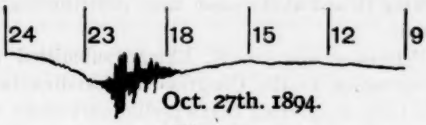


Fig. 10.

1894. The duration of the motion in Japan was about three hours. Other unfelt earthquakes have had durations exceeding five hours, and their amplitude has been much greater than the one here shown.

In addition to these examples of the movements of horizontal pendulums, observers will find many others of an extremely curious nature. Further information respecting these instruments can be obtained from Mr. R. W. Munro, Granville Place, King's Cross Road, London, W.C.

THE MOVEMENTS OF THE SURFACE WATERS OF THE NORTH SEA.*

By H. N. DICKSON, F.R.S.E.

It has probably never been doubted that we are far from having an adequate knowledge of the circulation of waters in the North Sea and the various channels connecting it with the North Atlantic, but the brilliant researches of the Swedish oceanographers, Ekman and Pettersson, have recently thrown our deficiencies in this respect into very striking relief. It has been shown that a complete discussion of the conditions obtaining in the Baltic is impossible until the incoming and outgoing currents are traced to their origins and endings; and that for this purpose isolated expeditions like those of the *Pomerania*, the *Drache*, or the earlier cruises of the *Jackal*, while they afford valuable information, must always fall short, on account of the rapid changes constantly occurring in different parts of the area. What is wanted is, as it were, a series of instantaneous photographs recording the distribution of temperature and salinity in the whole body of water between the Færoe Islands and the Gulf of Bothnia, and between the Norwegian Sea and the English Channel; and that not only in different seasons of

* Report on Part of the Work of the International Survey of that Area during 1893–94. By H. N. Dickson, F.R.S.E. Maps (plates), p. 344.

one year, but in successive years. The network of almost simultaneous observations which alone can make it possible to draw such synoptic charts, involves the combined operation of a larger number of ships than any one government can reasonably be expected to send to sea at one time; but the evidence brought out by the Swedish researches, amounting almost to actual proof that increased physical knowledge must lead to increased acquaintance with the habits and migrations of some of our food fishes, opens a way towards an international scheme of observations in which all the countries interested in the fisheries of the North Sea and the Baltic may take part, each exploring the areas more immediately concerning it, and at the same time contributing observations to the general fund.

Professor Pettersson and Dr. G. Ekman submitted a proposal for systematic co-operation to the Congress of Scandinavian scientists in Copenhagen in 1892, suggesting that a preliminary series of such surveys should be made in May, August, and November, 1893, and in February and May, 1894. The results were, under the circumstances, fairly satisfactory. In May, 1893, Danish and Swedish ships were at work, and in August these were joined by ships from the Kiel Commission and the Fishery Board for Scotland, while Norway took part in some of the later terminal cruises. Work was unfortunately greatly hindered during the winter months by weather of quite exceptional severity, H.M.S. *Jackal* being peculiarly unlucky in this respect; but a very considerable amount of material was nevertheless collected upon each occasion. Special reports upon the work done have already been published by the directors of the Swedish, German, and British expeditions—Professor Pettersson, Professor Krümmel, and the present writer—and it is here proposed to summarize the joint results of all the observations, in so far as they refer to the *surface* waters of the North Sea and the entrance to the Skagerak. In discussing the relation of these results to the currents of the North Atlantic and Norwegian Sea, I have collected all the available observations made on board merchant vessels within the periods named. Professor Pettersson was kind enough to work up the records of Danish and Swedish vessels, and to send me the results, and with these I have incorporated observations extracted from logs deposited in the Meteorological Office, to which Mr. R. H. Scott, F.R.S., courteously gave me access. I may here be permitted to express my thanks to my colleagues for entrusting to me this part of the work, and for the cordial way in which they have rendered every assistance in carrying it out. I have specially to thank Professor Pettersson for many hints and suggestions.

In considering the circulation of waters in the North Sea, we have to deal with the various sources from which these waters are derived, the relative amounts obtained from each, and the distribution and mixture of the different waters over the North Sea itself. The inflowing waters are in the main of two kinds—oceanic waters entering from the

north and west, and also to some extent from the Straits of Dover, and land waters entering from the Baltic and from various rivers; and the chief characteristics upon which we have to rely in identifying these are salinity and temperature. The oceanic water in its pure state always contains more than 35 parts by weight of salt in 1000, while the land waters under similar circumstances never rise above 34 parts per 1000: the range of temperature is in the former case much less than in the latter, the supply of fresher waters being to a large extent cut off by frost in winter, and rising in summer to a temperature much higher than is observed in the open sea. Between 34 and 35 per mille of salinity is found a water intermediate in its properties between the two just mentioned, and in nearly all cases formed from them by mixing. To this mixture has been given the name "North Sea water," although, as will be seen later, the actual mixture does not always occur within the North Sea itself. In a large and deep basin the amount of this intermediate water present at any time would be small compared with either of the others, for the fresh water would overlie the denser, and mixture would take place slowly; but in a shallow area like the North Sea, where the influences of wind and tide penetrate to the bottom, mixture sometimes takes place with amazing vigour and rapidity, so that the intermediate water sometimes occupies almost the entire basin.

In reviewing the distribution of temperature and salinity in the North Sea during the periods over which our observations extend, we are accordingly led to consider local influences which affect the mode and extent of mixture taking place, after which we may proceed to discuss the external influences regulating the supplies. These influences we may take to be, on the one hand, differences of specific gravity, themselves due to the variations of temperature and salinity; and on the other, the prevailing atmospheric conditions, the latter, in the case of surface waters under consideration, much more important than the former. The sketch-maps (Figs. 1 to 5), which are intended to accompany the charts of the salinity (Plates 1 to 5) and of the temperature (Plates 6 to 10) of the surface of the North Sea, need no further justification. They have been prepared from data extracted from the Daily Weather Reports published by the Meteorological Office, *i.e.* from land observations only; the average distribution of atmospheric pressure at 8 a.m.—from which the direction and force of the prevailing winds are inferred—is shown by solid lines, and the air-temperature by broken lines. Similar charts have been prepared for periods preceding those covered by the salinity charts (Plates 1 to 5); these are not reproduced, but any points of interest brought out by them are included in the following notes:—

Surface of the North Sea.

May 1 *to* 10, 1893.—(Plate 1.) Oceanic water covers a very small

area well to the north and north-east, and an isolated patch near the Straits of Dover. Water of 34 per mille salinity covers nearly the whole area, and extends to the west coast of Scotland. The fresher waters are restricted to a narrow strip on the eastern side. Temperature (Plate 6) tends to be highest near the coasts, but the isothermals run, in general, parallel to the lines of latitude, temperature rising to southward, but nevertheless highest in the open sea to north-west. The characteristic feature of this chart is, however, the remarkable uniformity in the distribution of temperature in and around the North Sea area, and this fact attains great significance from a consideration of the distribution of

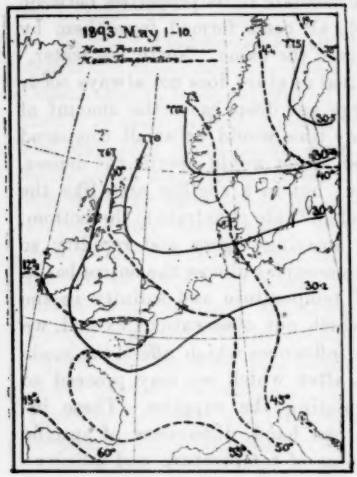


FIG. 1.

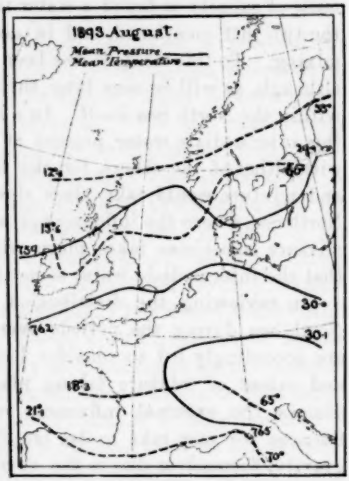


FIG. 2.

pressure. During the last ten days of April, a shallow anticyclone lay over the North Sea, and moderate anticyclonic winds from north-east continued during the whole period covered by the charts (Fig. 1). So far as the movements of the surface water are concerned, the conditions are probably those normally assumed when both oceanic and land streams are weak.

August, 1893; *the whole month.*—Plate 2 shows oceanic water covering a much larger area than in the preceding case, the axis of this area being also more central, while there is a marked influx from the Channel. Water of 34 per mille salinity is now a good deal restricted; the bulk of it lies in the south part of the North Sea and along the east coast of Great Britain. Fresher waters cover a greatly increased area, an immense volume of water of extremely low salinity now issuing from the Baltic at a temperature higher than is observed anywhere except in two isolated patches near the British coasts. Temperature gradients

are on the whole much steeper, the isothermals being generally tilted towards the continent, but tending to curve round an axis running north-westward between the Orkney and Shetland islands, obviously the effect of the strong tidal streams (see 'Report of the Fishery Board for Scotland,' 1894, p. 354).

The barometer charts show that in the latter part of July pressure was lowest over Southern Norway, giving fairly light gradients for westerly and north-westerly winds. During August the centre shifted westwards towards the Norwegian Sea, and then returned—on account of the passage of shallow depressions—giving south-westerly winds in the early part of the month, and then again westerly. The mean for the whole month (Fig. 2) gives light gradients for westerly winds, closely agreeing with the many-year average for August ('*Challenger* Reports,' *Ocean Circulation*).

In studying these maps, it is to be borne in mind that alike in Scandinavia and in the eastern parts of Great Britain August is a month of great local disturbances of temperature and rainfall, some of the eastern counties of England receiving their greatest monthly rainfall at that time. It would seem that in 1893 the wind influences over the North Sea were nearly normal, both the oceanic and continental inflowing streams being probably abnormally strong.

November 16 *to* 25.—Plate 3 shows 35 per mille water forming a blunt-ended tongue which extends over the greater part of the northern entrance to the North Sea; and the same water is intruded for a considerable distance from the Straits of Dover. The intermediate 34 to 35 per mille water occupies nearly all the rest of the area, except off the Norwegian coast, where the periodic influx of "bank water" from the Norwegian channel, first recognized by Ekman and Pettersson in 1890 (*Scottish Geographical Magazine*, 1894, p. 456), is again observed. Professor Pettersson informs me that the deep-sea observations of the Norwegian and Swedish expeditions, under the direction of Dr. Hjorth and himself, afford final and conclusive proof of this remarkable phenomenon. It is further noticeable that the supply of nearly fresh water from the Baltic is now wholly cut off.

The temperature of the surface water (Plate 8) is now lowest on the continental side, except off the east coast of Scotland, where the occurrence of up-welling under the conditions observed has been proved (*Journal of the Scottish Meteorological Society*, vol. viii. p. 332). There is a marked maximum at the entrance to the Skagerak.

The isobaric chart for the ten days preceding November 16 shows a strong minimum near the Færoe islands, the centre of which moved later (Fig. 3) to Northern Scandinavia, giving gradients for strong westerly and north-westerly winds. The period was marked by a succession of deep cyclones moving eastwards and north-eastwards, and included the great storm which travelled from south-west as far

as the Shetlands, and then recurved southwards along our eastern coasts.

In this case local and oceanic influences were probably more energetic than usual, and the result is shown by the sharp contrasts.

February 19 *to* 28, 1894.—Plate 4 shows that oceanic water of 35 per mille salinity now extends over most of the area, and is continued along the central axis throughout. Water between 34 and 35 per mille forms a narrow strip on each side, and in the north reaches the Norwegian coast. Fresher waters are restricted to a band near the German and Danish coast and to the Skagerak, water below 33 per mille being entirely confined to the last.

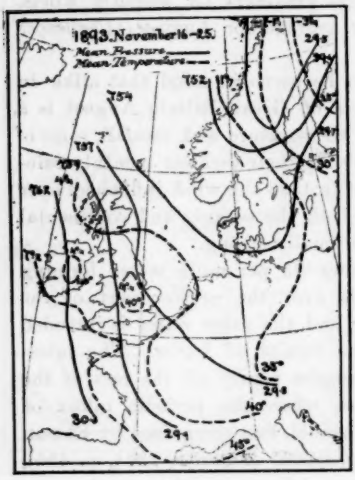


FIG. 3.

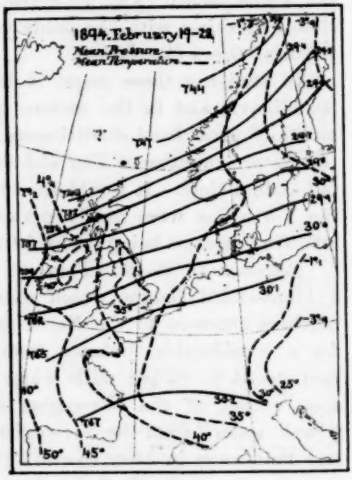


FIG. 4.

The distribution of temperature is altogether changed; the isothermals run north and south, temperature being highest to westward. In the oceanic area beyond, a large area of very uniform temperature is observed to the westward of the British Isles, to the north of which we may suppose, although observations are wanting, that the gradient becomes steep. The distribution gives additional interest to the barometer charts for the days preceding and during (Fig. 4) the period, which show steep gradients for westerly and south-westerly winds. The appearance of the charts would indicate that local and oceanic influences are strongly developed, while the land influence remains weak.

May 1 to 10, 1894.—Data are very incomplete, but it appears from Plate 5 that the 35 per mille water covers practically the same area as in the preceding February. Probably there is some freshening of the water

round the continental coasts, but the relative conditions seem very much to resemble those of February. Temperature shows a tendency to resume the normal east and west distribution, with increased warmth towards the north-west. Barometric pressure (Fig. 5) shows a minimum north of the Shetlands, with fairly steep gradients for westerly winds over the North Sea, tending to north-west near the Orkneys and Shetlands, and south-west on the continental side.

In addition to the charts here reproduced, Professor Pettersson has been able to map the distribution of surface salinity over the greater part of the area at the end of November, 1894, and the middle of February, 1895, from observations to which this country did not contribute. Both cases exhibit some peculiar features. In November, 1894, the 35 per mille water is split into two parts, one extending south-east from the Orkneys, and another off the Norwegian coast, reaching as far south as lat. 59° N. The total area covered by it is but small, by far the greater part of the North Sea surface being occupied by the intermediate 34 per mille water. Very fresh water—below 32 per mille—extends far north along the Norwegian coast, and the 32 per mille to 34 per mille forms only narrow strips. A more complete contrast to the corresponding chart for 1893 could scarcely be imagined; oceanic and bank waters are enormously reduced, while the Baltic stream, instead of being cut off as in 1893, makes its way far to the northward.

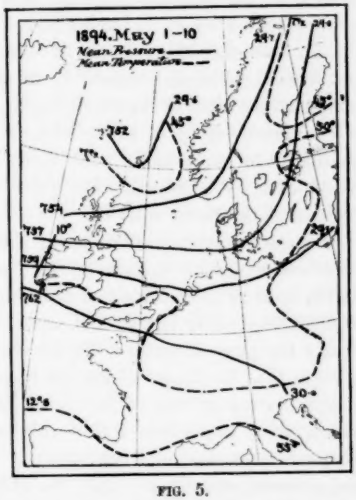


FIG. 5.

The daily weather charts show that anticyclonic weather persisted during most of the month from the Continent nearly across to Great Britain, while deep depressions moved north-eastwards, but kept well out in the Atlantic. This may account for the great weakness of the oceanic streams, including the "bank water;" and the greater strength of the Baltic stream is probably due to the mildness of the season.

In February, 1895, the 35 per mille water again formed a blunt-ended tongue, somewhat as in November, 1893, but it is remarkable for its westerly position, this being the only case where the 35 per mille touches the east coast of Scotland. Water below 32 per mille salinity has disappeared from the Norwegian coast. The daily weather charts show that a centre of high pressure was nearly stationary during the whole period over Scandinavia, while depressions moved northwards to the

west of the British Isles. Hence strong north-easterly winds were experienced over the North Sea, westerly winds outside, and low temperature generally. The oceanic stream is therefore probably strong, but there is a tendency to cover it over at the surface with "bank water," of which the supply is, however, deficient. The cold has entirely cut off the supply of fresh waters from the Baltic.

Comparing the three existing charts of salinity for February, 1890 (see *Scot. Geog. Mag.*, 1894, plate iii. p. 392), 1894, and 1895, we find in each case a central area of 35 per mille water at a temperature of 6° to 7° C., surrounded by colder and fresher waters—North Sea water, temperature 4° to 5° C.; bank water, 3° to 4° C.; and coast waters, 0° to 2° C. In 1894 the strong influx of oceanic water both from the north-west and from the Channel caused it to occupy an unusually large area, and temperatures were everywhere high. February, 1895, on the other hand, is characterized by a much smaller area of oceanic water, and large quantities of remarkably cold, fresh waters in the southern part of the North Sea. We remark that 1894 was the warmest, and 1895 the coldest, of the three winters.

We gather from the foregoing that the distribution of water of all salinities over the surface of the North Sea varies within very wide limits, both as to the size and position of the areas covered, and it may be altogether different at the same season in different years, and practically the same at quite different seasons in the same year. Hence it appears that the forces which produce the changes act rapidly; a change of distribution at the surface may be wholly or chiefly due to forces which have come into action only a short time before. A study and comparison of the maps confirms our division of these forces into *local* and *external*, and shows that the chief influence at work locally is the wind. It will be seen later that the wind has also a profound effect on the surface supplies of oceanic water, a fact which greatly increases the difficulty of separating out the results of local action in mixing the inflowing waters. In so far as existing observations enable us to surmount these difficulties, however, it may be suggested that—

1. Calm weather favours the spread of a thin layer of water of 34 per mille salinity over a great part of the surface of the North Sea, the result of previous mixing.

2. Strong northerly (N.E., N., or N.W.) winds tend to broaden the area covered by 35 per mille (oceanic) water, and to blunt its extremity, and the surface salinity on the whole is increased, the fresher outflowing waters being driven back. One very important effect is to send water between 33 and 34 per mille southwards along the west coast of Norway; and further investigation may show that these conditions are responsible for the influx of "bank water" into the Skagerak already referred to, which has been found to coincide with the period of the Swedish herring fishing.

3. Westerly and south-westerly winds tend to form a continuous strip of 35 per mille water along the whole of the central axis of the North Sea, probably because the oceanic streams are strengthened, but at the same time mixing goes on rapidly, and there is strong upwelling from the British coasts.

4. Easterly and south-easterly winds reduce the salinity as a whole by spreading the fresher waters over the surface. The oceanic water is covered over, or shows a small area close to the coast of Scotland.

It would, of course, be premature, at this stage of the investigation, to insist on the invariableness of these results, or to found important conclusions upon them. The actions are in all cases complex, and their reactions are undoubtedly still more so. One point only can hardly pass unnoticed, and may be suggested as lending additional interest and importance to further inquiry—the indication that during the colder seasons the presence of a large body of warm oceanic water in the North Sea constitutes a line of weakness at the edge of the great continental system of high pressure, along which cyclones tend to make their way, while a surface of fresher, colder water favours the extension of high pressure over the British Isles. A comparison of the winters 1893–94 and 1894–95, in relation to the surface temperature and salinity of the North Sea, brings forward a number of questions of this nature which press for early settlement one way or another.

The Inflowing Waters.

Turning now to the external influences controlling the volumes and velocities of the inflowing streams, it is evident that these must be considered in two divisions—the fresh or land waters, and the oceanic waters. With regard to the former, it may be said that the chief supplies come from the Baltic, while the British contributions are of small importance. The currents of the Baltic and Skagerak have been discussed by the Swedish hydrographers with a completeness which stands unrivalled in work of this kind, and we need, therefore, only again refer to Professor Pettersson's papers in the *Scottish Geographical Magazine* for 1894. For our present purpose it is to be remembered, in particular, that the supplies of these waters are much greater in summer and autumn than in winter and spring, the difference being in general greatest between a hard winter and a wet summer, and least between a mild winter and a dry, hot summer; that these waters are much the hottest in summer and the coldest in winter, and that therefore their relative lightness is greatest in the former season; that, as outflowing currents, they tend to split into two whenever from any cause their direction is altered, and that they tend to induce "reaction currents" of inflowing water under them.

The most important fact in connection with the supply of oceanic water to the North Sea is, that in the Færoe-Shetland channel, just

at the north-western edge of the continental shelf, a mixture of waters from different sources is constantly taking place. The current of Atlantic water pouring over the Wyville Thomson ridge sucks up the cold bottom water of the Norwegian Sea, and, mixing with it, has its own temperature lowered, thereby causing it to sink and in great part lose its horizontal motion. It is absolutely essential that we should possess a detailed knowledge of how this process goes on from year to year, of the various sources from which the waters are derived, and of the proportions in which they enter into the mixture. Much information is to be derived from the work of the *Porcupine*, *Lightning*, *Triton*, and *Jackal* expeditions, and from the Norwegian North Atlantic expedition, but a great deal remains to be discovered, and for this deep-sea observations alone will suffice. It will appear presently, however, that surface observations are of very considerable value.

We have to consider (*a*) the movements of the great north-easterly drift of warm surface water from the Atlantic, and (*b*) obscure and variable currents from northern latitudes. The maps of surface temperature for dates corresponding to the charts of the North Sea (Plates 6 to 10) present the following features:—

May, 1893 (Plate 6).—An axis of high temperature runs from mid-Atlantic north-eastwards to about 15° west longitude in the latitude of Ireland. It then splits into three branches: one runs up to the Færoe-Shetland channel, the warm stream being very narrow; a second runs due north to the south-east coast of Iceland, where it is blocked; and a third in a north-westerly direction to the west coast of Iceland, where it spreads out and is lost. A centre of cold to the east of Iceland extends south-eastwards, and there are signs of another such centre to the east of Greenland.

August, 1893 (Plate 7).—The warm axis in the Atlantic has moved about 6° to the westward. It splits into three as before, but the Færoe-Shetland stream has become still narrower, the east-Iceland stream has considerably diminished, and that to the west of Iceland has also narrowed, especially towards the south. Two well-marked cold axes are now apparent, one stretching from the east of Iceland to the Færoes, and a second coming down the east coast of Greenland and beyond Cape Farewell. It is to be noted that the warm axis which appeared off the western coast of Greenland in May is no longer to be found, having probably moved westwards.

November, 1893 (Plate 8).—The Atlantic warm axis has moved still further west, but it now bends more rapidly to the north-east. The data are insufficient to show the subdivisions completely, but it is noticeable that the north-easterly stream seems wider, and that the stream to the east of Iceland is almost absent. The observations indicate a well-marked cold axis from the east of Iceland, but this now runs due south, allowing greater expansion of the warm stream in the Færoe-Shetland channel.

February, 1894 (Plate 9).—The Atlantic axis has again moved eastward, and, so far as the observations go, there seems to be a wide stream entering the Færoe-Shetland channel.

May, 1894 (Plate 10).—The Atlantic axis lies far to the westward; the north-easterly stream is probably weak, but is narrowed and confined by the cold stream from the east of Iceland. The cold stream to the east of Greenland, and the absence of warm surface water to the west of Greenland, are again noticeable.

From these maps it would seem that the Atlantic streams are on the whole strongest in summer, but that their common source is at that season far to the west. The currents flowing northward may then be weakened by an unusually large delivery towards the Spanish and African coasts (the "west wind drift" and "Canaries current"); but the great branchings of the north-east stream are nevertheless more clearly marked than in winter, and we may connect this with the fact that the cold streams moving southwards from the eastern coasts of Iceland and Greenland are also most strongly marked in summer. In winter these streams are weak or altogether absent, and the warm north-easterly drift tends to spread itself uniformly over the surface of the Norwegian Sea.

At the same time there is evidence that the whole distribution varies greatly from year to year. The charts of mean surface temperature between Davis Strait, Iceland, the Færoes, and Scotland, recently published by the Danish Meteorological Institute, give monthly averages for the warmer seasons, and, so far as it is possible to compare these with the charts accompanying this paper, it seems that the average conditions are of much the same type as those we have described, except that the contrasts between the different streams are less clearly marked. In some years the state of affairs may be altogether different, but there remains little doubt of the immense importance of the effects of the polar currents at certain seasons in modifying the warm drifts from the Atlantic. The problem, indeed, resolves itself into one very similar to that already stated for the North Sea—an analysis of the external and local influences acting in the region between the Færoe and Shetland islands. The former are now (*a*) variations in the Atlantic stream, and (*b*) variations in the polar streams; and the latter the action of the winds in mixing the waters derived from these two sources, and in driving the mixture into the North Sea.

The polar streams are evidently greatly diminished in volume during winter and increased in summer, to an amount depending chiefly on the extremes of temperature in each case in different years. The strength of the Atlantic streams and the conditions of mixture depend partly on temperature, but chiefly on the intensity of wind action, and with this in view it may be worth while to glance at the changes in the distribution of atmospheric pressure controlling the

prevailing winds from month to month. The question is one of the varying relations between the "Atlantic anticyclone" and a belt of low pressure, really an immense cyclone track, which extends from the south-east of Greenland, round Iceland, and thence in a north-easterly direction. The Atlantic anticyclone is weakest in winter, consisting in January of a long belt of high pressure with two centres; the eastern centre increases in intensity and moves westward, attaining its maximum in mid-Atlantic in July, and thereafter extending east and west and diminishing. Hence what we may call the *propelled* surface currents are strongest in summer, but the north-easterly branches may be weakened by the greater area of north-westerly winds towards Spain and Western Africa. Towards autumn the source of these streams would move to the westward, as we have seen it did in 1893.

The *induced* streams, under which we include the continuation of the warm north-easterly drifts, the polar currents, and the mixed waters resulting from their meeting, are chiefly controlled at the surface by the Iceland depression and by the distribution of pressure over Western Europe. The low-pressure belt is most strongly marked in winter, and at the same season pressure is high over the Continent, air tending to flow outwards from the latter towards the former. In summer, on the other hand, pressure over Europe is diminished, and the Iceland depression greatly lessened in intensity. Hence we might expect Atlantic water to be most widely spread over the surface of the Norwegian Sea in winter, but that at that season it would be most difficult for it to gain admission to the North Sea. As the season progressed, the surface-water of the Norwegian Sea would be likely to contain an increasing proportion of water coming from the north by the east of Iceland, and it would become easier for the mixture to enter the North Sea at its eastern side, where it would be covered over by the outflowing Baltic waters. The changes in the prevailing winds seem also to account, in part, for the presence during summer of large bodies of the mixed waters, extending to a considerable depth near the north-western corner of the continental shelf, at the entrance to the Færoe-Shetland channel. I have elsewhere (Report of the Fishery Board for Scotland, 1894) discussed how these waters may find their way into the western part of the North Sea.

The great differences observed over the Norwegian Sea in different years point to a possible explanation of climatic phenomena similar to that hinted at on a smaller scale in the North Sea, inasmuch as a great influx of cold water from high latitudes—the result of exceptional warmth in the far north—must tend to keep atmospheric pressure above the average, while a wide distribution of warm drift water from the Atlantic must favour the development of the Iceland depression or its constituent cyclones.

Arrangements have been made by the Swedish and Norwegian

Governments for monthly expeditions during 1896, which will make deep-sea observations in the North Sea. Through the courtesy of the British Meteorological Office, the Danish Meteorological Institute, the United States Hydrographic Department, the Bureau Central Meteorologique de France, and the captains of a number of private vessels, the present writer is collecting material which it is hoped will be sufficient to allow of the construction of monthly charts showing the distribution of temperature and salinity over the whole of the Atlantic north of 40° N. lat. during the two years 1896–97. The combined investigations will undoubtedly do much to clear up many of the questions suggested by the preliminary work during 1893–94; but it is equally certain that they cannot attain to their full value, nor can the matter be finally set at rest, unless deep-sea observations are made simultaneously in the Færoe-Shetland channel, and at the north-western entrances to the North Sea.

THE GUINEA AND EQUATORIAL CURRENTS.*

By J. Y. BUCHANAN, F.R.S.

This is an atlas compiled at the Royal Meteorological Institute of the Netherlands from 2900 logs of Dutch ships, and it gives, besides the currents, the wind, rain, temperatures of the air and the sea surface, and some other less important details. The results are given for each month of the year, and the area included lies between the parallels of 2° N. and 24° N., and the meridians of 2° W. and 29° W. From the grouping of the observations, it is obvious that the great majority of the ships whose logs have been used have been bound round the Cape of Good Hope. The observations are most numerous in the squares from 400 to 500 miles from the African coast, where the conditions are subject to much less rapid and violent change than in the immediate neighbourhood of the shore. This, however, is unavoidable where the logs of ships making ocean voyages are the source from which the data are taken.

The currents logged and entered on the charts are obtained by the time-honoured plan of measuring the distance and bearing of the position of the ship by astronomical observation from that given by dead reckoning. The value of the observations so obtained depends mainly on two particulars—the kind of ship on which they have been made, and the skill of the officer who makes them. The logs used have no doubt been selected after careful criticism of the way in which they have been kept, and elimination of those not reaching the required standard. No information is given as to the character of the ships,

* 'De Guinea en Equatorial Stroomen.' Utrecht, 1895.

whether sailing or steamer, but it is probable that there would be a fair proportion of sailing vessels among them, and the steamers would be vessels of moderate speed. Well-kept logs of sailing ships often give very valuable results, especially in equatorial regions, where the winds are for the most part light, and where calms are frequent. It is then that the current drift enters as a large proportion of the day's reckoning, and can be taken out of it with certainty. In the case of steamers, even of very moderate speed, the ground is got over so quickly that the current has very little time to act, and the effect produced is a very small portion of the day's reckoning, and is liable to considerable uncertainty. It is a fact, not generally recognized, that ocean currents, and especially the equatorial ones, which are the most important of all, generally run in streaks of very moderate breadth in which the water runs with some speed, separated by comparatively slack water. A steamer crosses these streaks in a very short time, and is steaming for the greater part of the day in water having little motion. Sailing vessels, becalmed in a streak, may make quite a good day's run under the influence of the current alone. There is no more interesting physical study than that of the equatorial currents of the great ocean, but to do it at all satisfactorily considerable appliances are necessary, and, for the time being, it must be the principal employment of the ships engaged in it. While, therefore, we cannot attach much importance to the numerical values of the individual current observations recorded in the atlas, they are valuable as affording information on the general direction in which the water was moving in the interval between two observations—that is to say, whether the current was directed towards the east or towards the west. The easterly or counter equatorial current is composed of water of high temperature and low salinity as compared with the westerly running equatorial current beside it, and a great number of important properties of the water and of its inhabitants can be affirmed when the general direction of its motion is known. Information, too, with regard to the wanderings of the currents is valuable, and can be obtained from the charts of this atlas.

There are two sheets for each month. The first is the principal chart of the month, and it gives the current observations in each 1° square. In the centre is the number of days on which observations were made, and the currents observed are represented by arrows radiating in the proper direction from the centre, and marked so as to indicate the velocity in miles per twenty-four hours. In two tables, printed on the blank portion of this chart, are collected in convenient form the numerical details of the observations of current, wind, temperature, etc., so that the influence of one element on another can be followed. The second sheet for the month consists of four charts: I., giving, from the first sheet, the general direction of the current in each square. From

this chart we learn at once whether the current in the particular square has been most frequently an easterly one or a westerly one. Of the other three charts, II. gives the temperature of the sea surface in isothermal lines, III. gives the isotherms of the air, and IV. gives the wind-rose for each 5° square. As before remarked, the squares inshore include much fewer observations than those farther out to sea.

The atlas contains an enormous amount of detailed information in a very accessible form, and it is an important contribution to the literature of oceanography. It is impossible to notice more than one or two points. Nearly in the centre of the area covered by it is Cape Verde. This, like Cape St. Lucas at the extremity of the Californian peninsula and Cape Blanco on the west coast of South America, is the point where equatorial conditions begin in the neighbouring ocean. The same rapid alterations of temperature are found on rounding any one of the three points. North of Cape Verde the water inshore is abnormally cold, and always colder than the air. Here the north-east trade wind blows very steadily, causing a certain removal of surface water towards the south, the place of which is taken most easily by the deeper and therefore colder water of the neighbourhood. South of Cape Verde the easterly running Guinea current pours its highly heated water in towards the shore. On the polar side of Cape Verde there is a general drainage of water away from the shore and towards the sea; on the equatorial side of it there is a general drainage of water from the sea towards the land. The former is an area of emptying, the latter one of filling. The same holds good of points St. Lucas and Blanco on the American continent, which occupy similar positions on the Pacific to that of Cape Verde on the Atlantic; the great Central American bight, with Panama at its head, taking in the Pacific the place of the Gulf of Guinea in the Atlantic. Both seas have a very high general temperature, and both show the same remarkable seasonal fluctuations. The American meteorological atlas of the Pacific shows this very well for the Central American bight, and the Dutch atlas under notice, along with the British meteorological societies' Atlantic atlas, shows it well for the Gulf of Guinea.

The warmest months on the Guinea coast are January and February, the coolest are August and September. The Guinea coast runs east and west in a mean latitude of 5° N. In the month of January the average temperature of the sea surface is 28° C. in the gulf, and it falls if we proceed westward along the parallel of 5° N. to 26·6° in the westmost square of the chart. At this season the current is running very strong to the eastward close along the shore. Besides having a high temperature, the water has a low salinity. Further out to sea in this season the easterly moving water is confined within narrow limits, from 4° to 6° N. lat. In August and September the current still runs strong inshore, but the area over which an easterly set is experienced out at sea extends northward almost to the Cape Verde islands. At this

season the temperature of the surface water in the gulf is as low as 24° C., and rises to nearly 27° C. as we proceed westward. The water of the inshore current at this season has a much greater salinity than the warmer water of January, and there is reason to suspect that the easterly running inshore water of this season is a continuation of the strong easterly under current observed and measured in the *Buccaneer* in March, 1886. During the laying of the submarine cable from Fernando Noronha to Senegal this under current was observed far to the westward, and there is every reason to believe that it is a constant and important factor of oceanic circulation, the heart of which lies in the equatorial belt. It will be seen that we are but very imperfectly acquainted with the facts of the circulation of the equatorial waters. They can only be ascertained by special investigations, for which the opportunities are rare. Until some progress has been made in this direction, theories, accounting for the circulation of the water under the action of winds at a great distance, or otherwise, are apt to be misleading. All facts carefully observed are valuable, and the atlas under notice contains a great mass of them. It adds one more to the many important contributions of the Dutch to oceanography and marine meteorology.

RECENT AFRICAN BOOKS.

By EDWARD HEAWOOD, M.A.

THE stream of African literature continues to flow in unabated volume, and the record of the past year includes a number of works, each of which but a few years back would have seemed worthy of exceptional notice, but to which we can now merely refer in a general summary. Moreover, as some account of all the journeys has already appeared in the *Journal*, it will be unnecessary to describe afresh the routes followed. The illustrations, too, are so generally good and abundant that they need not be referred to in each individual case.

Colonel Monteil's volume * is produced in a style that well befits the importance of his great journey from the Senegal to Tripoli. Written during a limited absence from the scene of his exploits, it is of necessity limited mainly to a vivid personal narrative of the various episodes of the journey, the scientific matter being reserved for future treatment. More solid matter is, however, by no means lacking, for a valuable light is thrown on recent political developments within the extensive region traversed, for much of which we had no more recent information than that given by Barth and Nachtigal. Of much interest, *e.g.*, are the notes on the state of Mossi within the bend of the Niger, which, in the writer's

* 'De Saint-Louis à Tripoli par le Lac Tchad.' Par le Lieut.-Colonel P. L. Monteil. Paris: Félix Alcan, [1895].

opinion, is unique in possessing an ancient negro civilization, which has emerged from the barbarism elsewhere attaching to negro institutions. He also discusses various questions arising from the juxtaposition of fetishism and Islam, which latter has, he says, gained as yet little footing west of the eastern frontier of Mossi. He seems to have a high opinion of the military organization of the Central Sudan states, though in Bornu he saw many signs of decadence, and was able to presage to some extent the danger to which it was then exposed from the ambition of the adventurer Rabah. The commercial capital of the Sudan is said to be undoubtedly Kano.

Besides throwing new light on the hydrography of the southern tributaries of the Niger, Colonel Monteil makes some interesting remarks on the "dalhols," or swampy longitudinal depressions, with sharply defined lateral margins, which occur east of that river, and which he ascribes to the sudden outflow of the ancient Saharan sea—an opinion, however, which is not likely to be accepted without fuller investigation.

The author's belief in the possibility of traversing Africa with a very small armed escort, and also in the effect of decision and rapidity of execution in dealings with Africans, certainly seems to have been justified by the result in his case.

In M. Maistre's book* we naturally find more than in Colonel Monteil's of positive geographical discovery, corresponding to the larger extent of unexplored country traversed. Although the watershed between the Congo and Lake Chad had been already crossed both by Crampel and Dybowski, it is to M. Maistre that we owe the first clear definition of the various streams † which combine to form the Shari, for which again Barth and Nachtigal were our only previous sources of information. In addition to the details given in the course of the narrative, the concluding chapter gives a useful summary of the geography of the region between the Mobangi and Adamawa, a region of special interest as forming the transition-ground both from the equatorial forest to the more open country further north (itself comprising various zones), and from the domain of paganism to that of Islam. The lines of low hills which divide the basins of the Congo and Shari have, we are told, a general west-south-west and east-north-east direction, and appear to connect with an important orographical centre formed by the Bolo mountains. A noteworthy feature of the Shari basin is the prevalence of swamps with an impermeable subsoil of swamp-ore similar to that noticed by Schweinfurth. Much information is given as to the various

* 'A travers l'Afrique Centrale, du Congo ou Niger.' C. Maistre. Paris: Hachette, 1895.

† The three principal head-streams are said to be the Gribingi (unfordable at all seasons, and causing wide inundations during the rains), the Ba Mingi, and Bahar Sara. The last, which comes from the south, not the south-east, is identified with Nachtigal's Bahr Kuti, though it would seem more natural to connect this with the town of El Kuti reached by Crampel.

tribes of the country, such as the war-like Manjias, and the finely formed Saras of the south of Bagirmi (already mentioned by Nachtigal). The relations of the Moslems with their pagan neighbours are also discussed, the author agreeing with Colonel Monteil that the former are much more easy to deal with than the latter.

The want of a good general map embracing the whole region is perhaps hardly made up for by the extensive series of sectional maps on which the route is laid down, useful as these will be as a basis for the mapping of this part of Africa.

In this connection it may be mentioned that the scientific results of M. Mizon's journey from the Benue to the Congo in 1890–93, are now in course of publication in the *Bulletin* of the Paris Geographical Society. The first part appears in No. 3 of 1895, and also separately as a reprint. The route is laid down in a similar series of maps to those of M. Maistre, though on a slightly smaller scale. In the accompanying text the nature of the observations on which the positions depend is stated, the various itineraries being also described in detail. An introductory statement is made of the work accomplished in other directions (meteorology, natural history, ethnology, etc.), further details of which are presumably to be given in a subsequent part.

The work* in which Dr. Passarge records the results of the German Expedition of 1893–94 to Adamawa contains an unusually large proportion of scientific matter, and must long remain a valuable authority on the region with which it deals. The extent and variety of information brought home may be ascribed in great measure to the division of labour between the leaders of the expedition, which left Dr. Passarge free to devote his whole attention to the scientific work,† while the fact (partly due, it is true, to the frustration of the original plan) that the routes traversed the country in a variety of directions instead of following a single line, was also favourable to the acquisition of an extensive knowledge of the country.

That full use was made of the opportunities for observation is evident from Dr. Passarge's volume. It is divided into two parts, the first containing the narrative of the journey, combined with valuable details on the various tribes met with, their manners and customs, political and commercial relations, as well as on the geology and physical features of the country; whilst the second gives a connected view of the Central Sudan in its several aspects, the author considering the north and centre of Adamawa to belong essentially to this, but the southern section, on the central plateau, to a geographically distinct region. Positions were determined by means of astronomical observa-

* 'Adamawa.' Von Dr. Siegfried Passarge. Berlin: Dietrich Reimer, 1895.

† He records, however, the important share contributed to this by Baron von Uechtritz, who was prevented by ill-health from writing the record of the expedition.

tions with the theodolite, that of Yola being fixed with much care. The surveys are embodied in a large-scale map in three sections (by Dr. Limpricht), and others show the geological and ethnographical features, and the main routes followed by the Haussa traders.

Few more attractive books of its kind have appeared of late years than that in which Count von Götzen tells the story of his successful march across Africa in 1893–94.* In the first place, the illustrations are particularly well chosen, and give a vivid idea of the various types of scenery met with. But besides this, the author has to tell of an unusually interesting part of Africa. Whilst the first section of the route was by no means devoid of novelty, the interest naturally heightens as we are led to the more remote recesses of the continent, and learn for the first time accurate details concerning a region hitherto almost untouched by outside influence, and possessing such natural features as an active volcanic peak, and a picturesque rock-girt lake of considerable size.† The great central trough here maintains its well-defined character, Lake Kivu lying at the highest point of its floor, and the line of volcanic peaks forming the watershed between the northward and southward drainage within it.

Count von Götzen's further advance through the great equatorial forest is of hardly inferior interest, and in a special way from the light which it throws on much of the information gleaned by Livingstone, during his long detention in the Manyema country, from the Arab traders who were then first making their way north through the forest region inhabited by the Balegga. A section of this tribe ‡ was met with by the German traveller, who found that a route such as that used by Livingstone's informants passed through their district from Nyangwe to Lake Albert Edward. Count von Götzen failed to discover in the forest any of the grandeur attributed to it by Stanley, possibly because all minds are not equally impressed by the attributes of tracklessness and sombreness which certainly seem applicable to it. The picture in the present book of the neighbourhood of a forest clearing is in striking accord with that of Stanley.

---

* 'Durch Afrika von Ost nach West.' Von G. A. Graf von Götzen. Berlin: Dietrich Reimer, 1895.

† Ruanda, Lake Kivu, and Mount Ufumbiro, the easternmost of the line of peaks which terminates in the still smoking Kirunga, though known by name to Speke, have remained for over thirty years mere names on our maps. The general resemblance between Speke's Lake Kivu and the reality affords one more evidence of that explorer's geographical genius.

‡ The constant recurrence of sections of the Balegga in the forest region between Nyangwe and the Albert Nyanza (accounts of them reached Sir S. Baker in 1864, east of that lake), might almost favour the idea that the name is rather a general designation than a true tribal one. However, they seem to possess a language of their own, which Sir H. H. Johnston (*Proceedings R.G.S.*, 1890, p. 505) says is clearly related to that of Uganda. This tends to confirm their own legends of comparatively recent migrations, which also help to explain their scattered distribution.

The cartographical results of the journey are well shown in a two-sheet map by Dr. Richard Kiepert and Max Moisel.

When, in 1888, Professor Supan reviewed the history of African discovery during the preceding century, he called attention to three principal areas (apart from the Sahara) still unexplored, adding that when these had been intersected by the routes of travellers, then at last would the era of great discoveries be at an end. It is significant of the progress made since that time, that in the same year each of the three areas should be represented by important books of travel, neither, moreover, being entirely without a predecessor in the same field. Colonel Monteil's and M. Maistre's books deal with two respectively, while for the third we have Captain Bòttego's account—which fully deserves to rank with those already mentioned—of his explorations (with Captain Grixoni) in the Somali and Galla countries in 1892–93.* Although Captain Bòttego has been quickly followed by other travellers, his journey will always retain the distinction of having been the first to throw light on the hydrography of the upper basin of the Jub, of which our previous knowledge was of the vaguest. Our acquaintance with the climatology of this part of Africa was also extremely defective, so that the meteorological record, in which the traveller notes daily both the temperature at 6 a.m., noon, and 6 p.m. and the state of the sky, with the nature and duration of rainfall (if any), cannot fail to be of service. Besides a general map on the scale of 1 : 4,000,000, there are three large-scale sectional maps (1 : 1,000,000). On these the approximate limits of the fertile and arid regions are shown, the latter occupying apparently the whole surface (except the river valleys) at a distance from the hilly districts whence the streams take their rise. On the head-streams of the Jub, however, virgin forests were met with, which excited the admiration of the travellers.

Much information is likewise to be gained as to the Galla and Somali tribes, a chapter being devoted to an account of the latter and of the sultanate of Lugh, on the middle course of the Jub.

The next book to be noticed† takes us to almost the opposite extremity of the continent, but although the region dealt with is outside the limits of "Central Africa," it is one hardly better known than any tract within that area. On this account the additional details which Mr. Harris now gives of his adventurous journey to Tafilet are welcome, although the circumstances under which the journey was made naturally did not permit the carrying out of scientific observations. The fact that Mr. Harris was the first Englishman to cross to the south of the Atlas in itself gives an interest to the book. The only two Europeans who had preceded him to Tafilet, Caillié and Rohlfs, had reached the oasis from

* 'Il Giuba Explorato,' etc. Rome: E. Loescher & Co., 1895.

† 'Tafilet.' By Walter B. Harris. Illustrated by Maurice Romberg. Edinburgh and London: Blackwood, 1895.

other directions (the former passing through from south to north in 1828, and the latter arriving from the south-west in 1862 and from the north in 1864), so that Mr. Harris, coming from the west, was really breaking new ground, and his descriptions and illustrations of the scenery of the Atlas and its Berber strongholds, as well as his notes on the inhabitants, are of some value. The hardships of the journey were not slight, but the English traveller was fortunate in avoiding the suspicions which so nearly proved fatal to Rohlfs, though it is true the presence of the Sultan at Tafilet, with two Europeans in his camp, limited the time during which it was necessary to maintain the disguise adopted.

In connection with the early history of Tafilet, and its old capital Sijilmassa, Segelmessa, or Sijilmasiyah (the ruins of which were seen by Mr. Harris), it may be worth noting that Ibn Batuta visited the district in the fourteenth century, and even then extolled the dates, which are now so largely exported to the London market.

Before proceeding to notice one or two African books of a different class to the preceding, two more accounts of travel may be mentioned, which, however, contain scarcely enough of geography to entitle them to longer notice. These are Sir H. Colvile's 'Land of the Nile Springs' and Captain Swayne's 'Seventeen Trips through Somaliland,' both published last year. The latter contains a map reduced from the original surveys by the author for the Government of India.

In the two volumes dealing with Africa in the new issue of 'Stanford's Compendium,' an entirely fresh treatment of the subject was rendered indispensable by the immense changes introduced since the last edition of the older work was published. This has been well carried out by Mr. A. H. Keane, who has brought the subject-matter as well up to date as the rapid march of events in this continent will admit. The bulk has been extended to nearly double that of the former book, and increased attention has been paid to the historical, commercial, and ethnological sides of the subject, the last being no longer relegated to an appendix. The author's well-known qualifications as an authority on ethnological questions makes this a particularly useful feature of the plan. The difficulty of selecting a satisfactory subdivision of the subject has been well met on the whole. The great natural contrast between North and South Africa, both as regards physical features and inhabitants, affords a suitable division between the two volumes, though it may be noted that Ratzel is disinclined to lay so much stress on the differences between the Bantu and true negroes as Mr. Keane does. The division into chapters is based rather on political than natural facts, the case of the "Black zone," which is treated as a whole, being, however, an exception. The coast lands of Upper Guinea are included under that heading. As regards the arrangement within the chapters, a somewhat clearer distinction between the broader subdivisions might perhaps have facilitated reference. The description of physical features

seems also somewhat unnaturally placed after the political and historical survey; but the reason may possibly be a desire to bring into prominence at the outset the political facts which will in the future tend more and more to individualize the various regions.

From a purely geographical point of view, M. Vuillot's book on the Exploration of the Sahara * would perhaps have been of more general use if its plan had admitted the inclusion of the whole of that region within its scope. As, however, the main idea which underlies the whole is the elucidation of the work done in furtherance of the extension of French influence in the Sahara, and of the Trans-Saharan railway project in particular, the author confines himself to those journeys—certainly by far the most numerous—which led through the regions south of Morocco, Algeria, and Tunis. Thus no mention is made of the earliest modern Trans-Saharan journeys—those of Hornemann, and of Denham, Oudney, and Clapperton; though, as Barth remarks in his preface, the labours of these materially assisted their successors—while the work of Nachtigal also falls without the sphere of the book. Nor is there any reference to the history of the Sahara and its trade previous to its exploration by Europeans during the present century. As far as it goes, however, the story is fully and clearly told, the particular importance of each journey being carefully brought out, while the numerous route-maps scattered through the text, in addition to the excellent general map at the end, greatly facilitate the comprehension of the subject. Considering the large number of French Saharan explorers, whose works are not always accessible to general readers, the book will be extremely serviceable to those desirous of acquainting themselves with the details of French enterprise in this region. In the concluding chapter the author discusses the measures most urgently needed to secure to France the benefit of its trade, as to the prospects of which he shares the sanguine views prevalent among his countrymen.

The last book on our list is the useful bibliography of the Congo,† which has been prepared under the superintendence of M. A. J. Wauters. The care and labour which have been expended on this work may be judged from the fact that the entries include, in addition to books, not only articles from geographical and other periodicals, but also particular chapters of larger works which treat of some one branch of the general subject. It is restricted, however, mainly to books, etc., published since 1880, though a few standard works of an earlier date, such as Tuckey's narrative, are included. For the early literature of the subject, reference is made to the bibliographies of Gay and Paulitschke. The book is divided into sections, embracing, in addition to more general subjects,

* 'L'Exploration du Sahara.' Par P. Vuillot. Paris: A. Challamel, 1895.

† 'Bibliographie du Congo, 1880–1895.' Par A. J. Wauters, avec la collaboration de M. Ad. Buyl. Brussels: Office of the *Mouvement Géographique*, 1895.

the various branches of scientific and economic geography, the slave trade, missions, etc. The final arrangement is an alphabetical one under authors' names.* M. Wauter's book should be a most useful guide to the voluminous Congo literature of recent years.

BOUNDARIES OF BRITISH GUIANA—THE EVIDENCE OF MAPS.

By CLEMENTS R. MARKHAM, C.B., F.R.S., President R.G.S.

[In a communication to the *Times* of February 6, Mr. Markham examines the evidence afforded by maps as to the boundary between British Guiana and Venezuela. It will be useful for handy reference to reprint that communication here. A few slight corrections have been made, and some political references have been omitted.]

The evidence of maps in boundary questions is important both directly and as illustrating and supporting the evidence of other documents. In the elucidation of the question of the limits of British Guiana, the special light thrown upon it by cartographic documents is of more than ordinary importance. As the map-room of the Royal Geographical Society is a national institution, containing a collection of great value which serves to illustrate the question in its various bearings, it has become a duty to place the public, both in this country and in America, in possession of the cartographic evidence in the Society's collection. Chief Justice Daly, the venerable president of the New York Geographical Society, has already performed a similar useful service by reviewing the evidence of the maps in the collection of that society (see *New York Herald*, January 19, 1896).

The Guiana maps are naturally divided into four groups—first, the early maps showing the names by which the region was first known; second, the maps derived from Spanish sources; third, the maps setting forth the boundaries of Dutch Guiana; and, fourth, the results of more recent British discoveries and surveys.

Our examples of the first group are numerous, and the following are representative as regards the region between the Orinoco and the Amazon. The famous atlas of Ortelius (1570) contains a map of South America with the word Caribana occupying the space between the two great rivers. Hondius, in his atlas of 1623, also names the region Caribana, with the word Guiana more inland. The two Amsterdam atlases of Visscher (1651) and Blaeuw (1665) have the name Guiana, while Janson and Herman Moll follow Blaeuw. The word Caribana is derived from Carib, and indicates the country occupied by the Carib Indians. In the days of Raleigh the name was given to a chief of one of the tribes, also spelt Carapana. The evidence derivable from these early maps, from 1570 to about 1670, is that Caribana, the region now called Guiana between the Orinoco and the Amazon, was not occupied by the Spaniards, but by independent Carib tribes.

Spanish claims were not, therefore, derived either from discovery or occupation, but from an imaginary title conferred by their interpretation of the Bull of Pope Alexander VI., as modified by the Convention of Tordesillas, dated June 7, 1494. According to this arrangement, a meridian line was to be drawn from pole to

* It may be of use to mention that English authors not unfrequently appear under names not properly part of the surname (Travers Twiss, Silva White, etc.).

pole, at a distance of 370 leagues west of the Azores and Cape Verds, which were assumed to be in the same longitude. All to the westward of the line was to belong to Spain; all to the eastward to Portugal. The position of the meridian was never fixed, and the two countries continued to dispute over it until they ceased to have any American colonies. It depended on the point of departure, the number of leagues in a degree, and other details. The Spanish interpretation is shown on the anonymous map of 1527, sometimes ascribed to Fernando Columbus, and on the Ribero map of 1529. It makes the Pope's meridian strike the American continent a little west of the mouth of the Amazon, and thus includes all the Guianas and half Brazil on the Spanish side. The Portuguese view is shown on the Cantino map of 1502 and others, and Mr. Harrisse, the highest American authority on this subject, places the Portuguese version of the Pope's meridian, as modified by the Tordesillas Treaty, in 62° 30′ W. of Paris ('Les Corte-Real,' p. 86). This leaves Guiana on the Portuguese, or eastern, side of the line, and disposes of the Spanish claim and of the more extravagant Venezuelan claim which is based on it. But the true position of this meridian has never been decided, and no country, other than Spain and Portugal, was in any way bound by it. This explanation is necessary, because the Borgian meridian represents the sole ground on which the claim of Spain and of her inheritor, Venezuela, is based. It is also necessary to bear in mind that the eastern province of the Spanish Captaincy-General of Venezuela was called Nueva Andalusia, and extended from Cumana to the Orinoco, including the few Spanish settlements on the right bank of that river. When a map-maker wanted to set forth the imaginary title derived from the Papal Bull, Nueva Andalusia was written all over the map, including the Guianas, down to the Amazon.

We may now proceed to review the second class of maps derived from Spanish sources. We first find "Neuva Andalusia" written across Guiana on an undated map of De l'Isle, who lived between 1675 and 1726, and on others published by Mortier and Couvens, of Amsterdam. These maps represent the last tradition of the Papal Bull, which was fast dying out. One of the first maps which acknowledges existing facts is that in the French translation of the work of Father José Gumilla in 1758, which shows the correct Dutch boundary along the mountains of Imataca, separating the tributaries of the Essequibo from those of the Orinoco. By the Treaty of Westphalia, in 1648, more than a century earlier, it was settled that Spain and Holland should continue in possession of such territories as either respectively then held or possessed, those territories not being further described. In 1621 the States-General had granted a charter specifying the mouth of the Orinoco as the western limit of the territory of the Dutch West India Company, and Spain subsequently recognized the right of Holland to the whole basin of the Essequibo by implication, in various ways. But the Spaniards were naturally wedded to their Papal Bull, and were slow to allow long-established facts to appear on their maps. Father Gumilla set an excellent example in 1758. But then followed a map published in 1775 by Juan de la Cruz Cano, on which a line was drawn, not to show the boundary claimed by the Dutch and acknowledged by Spain, but the supposed limit of territory actually settled by the Dutch and under cultivation. This line follows the Essequibo to the junction of the Cuyuni, then ascends the Cuyuni to the junction of a little stream called the Tupura, and follows the Tupura to its source, whence a line is drawn to the source of the Moroko, the course of which it follows to the Atlantic. The whole basin of the Pomarun is thus included. But it by no means follows that the territory beyond this line was claimed as Spanish. It represents the country within the sphere of Dutch influence not actually settled by the Dutch at that time, but occupied by the Caribs and other tribes who were allies of Holland, and had never allowed a Spaniard to enter it.

The Cruz map, with its boundary-line, continued to be copied by map-makers for many years; for instance, in 1807 by L. D'Arcy de la Rochette, in 1808 in Cary's Atlas, in 1810 in Arrowsmith's Alcedo Atlas, and also by travellers who derived their information from Spaniards in Venezuela, such as Humboldt (1800–1804) and De Pons (1801–1808). Humboldt describes the line drawn by Cruz, but adds that it is not recognized by the Dutch, who place their boundary at the river Barima, and thence to the Cuyuni. De Pons ('Voyage à la Partie Orientale de la Tierra Firme:' Paris, 1806) also describes the line of Cruz, observing, however, that the Spaniards practically do not occupy one inch of the basin of the Essequibo, where the natives defend their independence and are allies of the Dutch. The line of Cruz is also adopted by General Codazzi in his well-known map of Venezuela published in 1840, who shows the positions of several old Dutch forts and posts. This Cruz line gives the English both banks of the Essequibo from the junction of the Cuyuni to the mouth, and is sanctioned not only by Spanish authorities, but by Codazzi, the highest Venezuelan authority, who died in 1859. Yet the Venezuelans now claim the line of the Essequibo to its mouth. They have gone so far as to publish a second edition of the Codazzi map in 1876, under the name of one Miguel Tejera, with the words "Territorio usurpado por los Ingleses," written over the part conceded both by the Spaniards and by Codazzi!

The geographical dictionary of Antonio de Alcedo, published in 1787, is the first Spanish work which begins to acknowledge established facts. Yet, under some heads, even Alcedo clings to the Papal Bull. Thus Nueva Andalusia is described as extending over Dutch, French, and Brazilian Guiana to the mouth of the Amazon. But when he descends to details, he tells us that the Dutch had settlements on the Pomarun surrounded by plantations and cultivated lands, and that they extended their influence up the Mazarusia, Cuyuni, and other rivers.

We now come to the third group of maps, which shows the real boundary of Dutch Guiana. This group is based on the labours of the illustrious French geographers of the seventeenth and eighteenth centuries, commencing with the beautiful atlas of Sanson, published in 1669. The name of Caribana here appears across the territory from the Orinoco to the Amazon, while Nueva Andalusia is correctly shown as extending from Cumana to the Orinoco, with a small tract on the right bank of that river. The map in the atlas of F. de Witt, published in 1688, follows Sanson. But it was D'Anville, the greatest geographer of his age, who in 1748 first delineated the true boundaries of Dutch Guiana. He followed Sanson and F. de Witt, but he would not be satisfied without authentic and original information. He, as geographer to the King of France, received authentic information from the Spanish Government. Moreover, as a geographer, he would see that the Dutch, having been established for a century and a half on the Essequibo, and having extended their influence up its tributaries, had a right to claim the whole basin of that river, allowing for legitimate territorial expansion; for no part was occupied by Spaniards, with the exception of some religious missions in the valley of the Yuruari. Chief Justice Daly has well illustrated this point by the case of Louisiana. The French colony extended little beyond the delta of the Mississippi, but the French Government ceded to the United States the whole sphere of its influence, from the mouth of that river to its head-waters. D'Anville accordingly showed the Dutch boundary as including the whole basin of the Essequibo. In the 1755 English edition of D'Anville's Atlas the same boundary-line is shown, and in the 1772 edition the boundary is coloured. Since that time map-makers have been almost unanimous in following D'Anville. In Jeffrey's West India Pilot (1775) the Dutch boundary begins near the mouth of the Barima, and also on the

chart of Captain Thompson (1783). The same boundary, giving the whole basin of the Essequibo to British Guiana, is shown on every map of any authority down to Kiepert, Stieler, and Andrée. More recent editions show the first Schomburgk line.

By the Treaty of 1814 the Dutch ceded the portion of Guiana which includes the basin of the Essequibo to Great Britain. Spain was a party to the treaty, at a time when that country was in full possession of Venezuela.

The fourth group of maps shows the British discoveries and surveys since 1830. The discoveries were energetically prosecuted by the Council of the Royal Geographical Society from 1834 to 1839, for at that time the head-waters of the Essequibo and its tributaries were entirely unknown. The Council selected an accomplished Prussian traveller, named Robert H. Schomburgk, to explore British Guiana, paying his expenses and drawing up his instructions. During his first scientific expedition he ascended the Essequibo far beyond any point previously reached, discovered the King William Falls, and explored the course of the Rupununi. In 1836 he explored the Berbice and Corentyns to their sources. In 1837 and 1838 he explored the Essequibo to its source, and connected his scientific work with that of Humboldt on the Upper Orinoco. In 1840 Schomburgk received the gold medal of the Royal Geographical Society, and in the following year he became her Majesty's Commissioner to survey the boundaries of British Guiana. He explored the Waimi and Barima, and delineated a boundary by which a large extent of British territory, comprising the whole valley of the Yuruari, was given up to Venezuela. Even then the Venezuelans had commenced their encroachments into British territory, and the line was designed to satisfy them and to secure a good understanding. The line was drawn on a just and well-defined principle, conceding to Venezuela the Yuruari and Curumu valleys, which had been occupied by the Venezuelans, and retaining the territory which had never been occupied by Spaniards or Venezuelans. The line commences at the mouth of the Amacura, on territory which had belonged to Holland since 1621, follows that river to its source, includes the basins of the Barima and Barama, and then follows down the Akrabisi to its junction with the Cuyuni. That river, then, becomes the boundary to its source. A first and a second Schomburgk line has been shown on maps, and this has been interpreted as vacillation. But there has been no change in the line itself, as explained above. The change on the maps is merely due to variations rendered necessary by more recent discoveries and more accurate surveys. Five of Schomburgk's maps were published in the *Journals* of the Royal Geographical Society; and a very excellent map of British Guiana, compiled from them on a scale of 7 miles to an inch, was engraved in 1875. Sir Robert Schomburgk also drew an excellent map for the edition of Raleigh's 'Guiana,' which he edited for the Hakluyt Society.

Since the days of Schomburgk, the falls of Kaieteur on the Potaro have been discovered by Mr. C. B. Brown, Mount Roraima has been explored by Flint, Whitely, and im-Thurn. Mr. im-Thurn has done a great and useful work in the north-west district of British Guiana, and Mr. G. G. Dixon has discovered the source of the Barima.

It will have been seen, from the evidence of maps, that Spain had no claim to British Guiana; that Venezuela, therefore, inherits no claim; and that even if the territory was adjudged not to belong to Great Britain, it in no way follows that it belongs to Venezuela. The right of Great Britain rests partly on discovery, on the Dutch possession of three centuries, on effective occupation, and on treaty. The evidence derived from maps is important in itself, and it will certainly serve to illustrate and give additional force to the documents in the forthcoming Blue-book.

CUINET'S 'TURKEY IN ASIA.'*—REVIEW.

By GEO. G. CHISHOLM, M.A., B.Sc.

THE first two volumes of this laborious and important work have already been briefly noticed in the *Proceedings* (1891, p. 739, and 1892, p. 569), and the parts in which the subsequent volumes have been issued have each been entered, as they appeared, in the Bibliographical notes of the *Journal*. The work continues to the end to be of the character described in the notices referred to. It is essentially a work of detail, the nature of which is sufficiently indicated in the preface, where it is stated to be "a compilation of statistical notes made on the spot in the course of different journeys made during the past twelve years," that is, previous to 1890. The arrangement of the information is in accordance with the administrative divisions—vilayets, sanjaks, and kazas. The headings under the vilayets are: Administrative division; population by races or religions; manners, customs and origins of the population; schools; commerce; navigation; climate; agricultural products; mines; forests; cattle; rivers; lakes; fisheries; roads; means of transport; industrial products; revenue and expenditure. The headings vary somewhat under the different vilayets. Some of them are repeated under the sanjaks, and some under the kazas. From this account it will be seen that no attempt is made at a description of Turkey in Asia from a geographical standpoint, and it would be very difficult to collect from this book a general idea of the region to which it relates. In the introduction there is a brief account of the administrative system of Turkey, followed by a table of the vilayets of the whole Turkish empire; but there is nothing else of a general nature, and no assistance is given in comparing the information given under the same headings in different sections of the book. Thus, if we find under the vilayet the statistics of agricultural produce, we have to turn up all the corresponding tables under the sanjaks composing the vilayet if we want to find out the proportions in which these products are distributed over the area. A work of this kind obviously requires an index, but none is supplied. Still, with all these drawbacks the work is of great value, supplying as it does information which in most cases can be found nowhere else, at least in a collected form. Notices of the chief towns are given under the kazas, and with reference to them, as well as under the heading "Origins of the Population," numerous interesting historical particulars are inserted. Under the head of climate, which is repeated at every sanjak, there is a large number of valuable notes as to the health of different localities.

Most of the figures in the book must, of course, be taken as merely approximate estimates, and it should be mentioned that for the areas it

* 'La Turquie d'Asie.' By Vital Cuinet. Paris. 4 vols. 1890-95.

would appear, from the procedure followed under the first vilayet treated of (Trebizond), Cuinet has merely adopted the official figures in *deunums* converted into square kilometers at the rate of 9·193 ares (·0009193 sq. km.) to a *deunum*, and that accordingly Cuinet's areas are not to be preferred to the careful calculations of Wagner and others. The discrepancies between Cuinet's areas and those of more trustworthy authorities are in some cases wide. For example, the island of Crete, which, in accordance with the classification of the official salnameh, is treated in this work as part of Turkey in Asia, has an area assigned to it of 7640 sq. km., against the 8618 sq. km. of the *Bevölkerung der Erde*, and the 8694 sq. km. of Strelbitsky.

Besides a general map showing the administrative divisions of Asiatic Turkey (exclusive of Turkish Arabia, which is not embraced in this work), there are special maps of the vilayets. In the preface these are all stated to be on the scale of 1 : 1,000,000, but this is not the case. The only maps on that scale are those of the vilayet of Brussa (along with the mutessariflik of Ismid) and the vilayet of Constantinople, and the scales actually adopted vary from 1 : 1,000,000 to 1 : 2,500,000. These maps are somewhat roughly drawn, minute accuracy not having apparently been aimed at. The lines of latitude and longitude are sometimes inconsistent, and the kilometer scales inaccurate. The maps do not show the surface features, but they give, among other things, the boundaries of the sanjaks and kazas, carriage roads and railways completed and projected, bridle-paths (*sentiers*), and the distribution of woods and forests and of salt-pans.

THE GEOGRAPHY OF MAMMALS.*

By W. L. SCLATER, M.A., F.Z.S.

No. IV.—The Ethiopian Region.

Sect. 1.—Boundaries of the Ethiopian Region.

The Ethiopian Region contains the whole of Africa south of the Sahara, together with Southern Arabia and the island of Madagascar. As in all other cases where there is a long land-frontier between two neighbouring regions, so here it is impossible to lay down anything but an approximate line of demarcation between the Ethiopian and Palæarctic Regions.

The boundary usually adopted is the line of the tropic of Capricorn, which strikes Africa between Morocco and Senegambia, runs through the middle of the Sahara, crosses the Nile between the first and second cataracts, and passes through Arabia to the neighbourhood of Oman, on the Persian Gulf. Most of the country through which this line passes is desert, and its mammalian fauna is consequently meagre. Mr. O. Thomas (6) has recently published an account of a collection of mammals received at the British Museum from Oman, which shows, as would

---

* Continued from vol. v. p. 483. Map, p. 344.

naturally be expected, that "the geographical relationships of this district are about equal with Africa and India; three of the species being distinctly African in affinities, three Indian, and the remainder either peculiar or widely spread and of no special significance." On the whole, therefore, the line of the tropic of Capricorn, adopted by Wallace, seems to be a very suitable boundary.

Besides the island of Madagascar and its appendages, which contain one of the richest and most interesting of all known insular faunas, and forms a very important subregion, which will be considered in greater detail below, the Ethiopian Region possesses other islands. These, however, are mostly Oceanic, and are not nearly of so great importance as Madagascar.

The Azores, Madeira, Canaries, and Cape Verde groups, although geographically African, seem to have derived their faunas chiefly from Europe. They therefore belong to the Palæarctic Region, and will be dealt with under that head.

The islands of St. Helena and Ascension, situated in the South Atlantic, are both of them of volcanic origin, and separated from the mainland of Africa by more than 800 miles of deep water. Neither of these islands possesses any vertebrate land-fauna at all. The only land-groups well represented in them are the beetles and the land-shells—a study of which shows that the affinities of these islands are to Southern Europe and Southern Africa, but that the fauna is in all probability an exceedingly ancient one; since its peculiarities are very great, and opportunities of migration of new forms to these islands have been few and far between.

The other islands in the Atlantic connected with Africa are Fernando Po, Prince's Island, St. Thomas, and Anno Bon, all situated in the Gulf of Guinea at various distance from its head. Fernando Po, an island of some 40 miles in length, but separated from the mainland by a somewhat shallow sea about 20 miles across, is inhabited by a considerable number of mammals. Among these are species referable to no less than nine genera, such as *Hyrax*, squirrel, porcupine (*Atherura*), linsang (*Poiana*), bats, lemurs, and monkeys. There seems to be no record of the bat and of two of the monkeys occurring on the mainland of Africa, though it is quite possible that they may be found there at some future date, since Fernando Po has been apparently much more thoroughly explored than the adjacent mainland.

The other islands above mentioned, Prince's island, St. Thomas, and Anno Bon, are all considerably more distant from the coast of Africa, and, so far as we know, do not possess any native mammals. A certain number of land-birds have been obtained from these islands, and a few of these are peculiar, but they are all closely allied to forms that occur in the neighbouring West African mainland.

The most important islands in the Indian Ocean are, apart from Madagascar, Socotra, the Seychelles, the Amirante islands, the Comoros, and finally Réunion, Mauritius, and Rodriguez.

Socotra is situated about 150 miles due east of Cape Guardafui, the extreme eastern point of Africa. Its fauna and flora were carefully investigated some years ago by Professor Bayley Balfour (1). He found that the only mammals inhabiting the island are a bat, which he was unable to obtain, and a civet cat (*Viverricula*), met with also in South Asia, and probably introduced by human agency.

The Seychelles are distant about 700 miles from the northern point of Madagascar in a north-easterly direction, a more or less continuous chain of islands (Amirante, Providence, and Farquhar) forming a series of stepping-stones between them. But two narrow deep channels of over 1000 fathoms run between the Seychelles and Amirante on the one hand, and between Amirante and Providence on the other, thus cutting the Seychelles off from Madagascar by their deep water.

There do not appear to be any indigenous terrestrial mammals in the Seychelles,

except two bats, which have been recorded as occurring there. The land-birds are most of them peculiar, though belonging to genera found in Madagascar or Africa; the reptiles and amphibians are fairly numerous for islands such as these, and several of the species are not found elsewhere. It is difficult to say whether these islands have ever had a land-connection with Madagascar, but probably, if such were ever the case, it was at a considerably remote time, geologically speaking.

The Comoros are a group of several islands lying about midway between the most northerly point of Madagascar and the mainland of Africa. They are separated from Africa by the Mozambique channel, more than 1000 fathoms in depth, while the depression between them and Madagascar is considerably less. Inhabiting these islands there are three bats, two of the genus *Pteropus*, entirely absent from the mainland of Africa, but found in Madagascar and the other islands of the Indian Ocean. There is also a peculiar species of Lemur (*Lemur mayottensis*) and the Indian civet (*Viverricula*), which last is also found in Madagascar and Socotra, and has in all probability been introduced by human agency. A fair proportion of the land-birds of the Comoros, though in some instances peculiar, belong to Madagascar forms, and everything goes to show that the relations of this group of islands is with Madagascar rather than with the mainland.

The islands of Réunion, Mauritius, and Rodriguez are distant from Madagascar in an easterly direction 450, 550, and 800 miles respectively. They are all of volcanic origin, and separated from Madagascar by water of more than 2000 fathoms in depth. As would be expected, these islands are thoroughly Oceanic, and possess no indigenous mammals or amphibians; while the land-birds are few in number, and belong mostly to genera found in Madagascar.

The most remarkable feature, however, of the fauna of these islands is the former existence of a group of flightless ground-birds now quite extinct, but some of which were found in great numbers when the islands were first discovered. These are the dodos of Mauritius and Réunion respectively, and the solitaire of Rodriguez. These birds form a distinct family—the *Dididæ*, probably allied to the pigeons, but of somewhat obscure affinities. It seems that the ancestors of these birds must have reached the islands in very early times, and that most of the striking peculiarities exhibited by them were gradually acquired after their arrival in the group.

We may, at any rate, conclude that these three islands are truly Oceanic, and that they have never had a land-connection with Madagascar or elsewhere.

Sect. 2.—General View of the Mammal-Fauna of the Ethiopian Region.

The Ethiopian Region, as will be seen by looking at the table of the numbers of families, genera, and species given at the end of the first article of this series (*Geographical Journal*, 1894, p. 104), is the richest of the six regions as regards the total numbers of its families, genera, and species of mammals, although the percentage of peculiar forms not found in other regions is hardly so high as in the Neotropical and Australian Regions. This may, however, be accounted for by the consideration that there is a long land-frontier between the Ethiopian and the Palæarctic Regions, though this is chiefly occupied by desert.

Out of the nine orders of terrestrial mammals the Ethiopian Region contains representatives of seven, the marsupials and monotremes being alone absent. The edentates of this Region are represented by two families. One of these, of which the sole genus is the aardvark (*Orycteropus*), is quite restricted to the Region. The other, containing the scaly anteaters (*Manidæ*), is found also in the Oriental Region. These two forms are in most respects more closely allied to one another than to any of the edentates of the New World.

It is, however, the animals belonging to the order Ungulata which form so conspicuous a factor in the Ethiopian fauna. These are distributed among twenty-nine genera, of which no less than twenty are not found anywhere outside this Region.

The antelopes, of the family *Bovidæ*, which are most of them large animals living in vast herds in the more open country of eastern and southern Africa, take up the greater number of these twenty-nine genera. These are perhaps, at the present epoch, the most notable feature of the African fauna, but will doubtless, owing to the unceasing persecution of hunters and sportsmen, become rapidly less so. Already the larger antelopes are nearly extinct in Cape Colony south of the Orange river, and there can be little doubt that, unless special precautions are taken, the large mammals of Africa will very soon disappear like those of the United States before the express and repeater.

Beside the numerous genera of antelopes, the Ethiopian Region has exclusive possession of two other conspicuous forms of the ungulates—the hippopotamus and giraffe, each of which forms a special family, while it shares the rhinoceroses, the elephants, and the chevrotains with the Oriental, and the horses (*Equidæ*) with the Palæarctic Region. The only important family of ungulates not found in the Ethiopian Region is the deer-family (*Cervidæ*). The total absence of this otherwise widespread family it is difficult to explain. Palæontology does not help us much, since the members of the deer-tribe appear to have been already well established and abundant in Europe during early Pliocene times, and were contemporaneous with antelopes and other ungulates, which have availed themselves of the opportunity of spreading southwards to Africa, while the *Cervidæ* have apparently remained obstinately attached to the Palæarctic Region.

Turning now to the rodents, we find that the Ethiopian Region possesses representatives of a considerable number of genera, twenty-seven of which, out of a total of thirty-nine, are confined to the region. Two of these genera are sufficiently distinct to be entitled to family rank. These are, first, *Anomalurus*, a form resembling the flying squirrels in having a flap of skin available for imperfect flight extended between the fore and hind limbs. But the anomalures differ from the true flying squirrels (*Pteromys*) in having a long cartilaginous process extending from the elbow-joint to support the parachute, and also in being provided with strong imbricated scales attached to the lower surface of the tail, which are probably of great assistance in climbing.

The second peculiar rodent of family rank is *Lophiomys*, a curious arboreal animal allied to the rats, but differing from them in several anatomical features, and in having a long crest of hair upon the back. Only one species is known, which is restricted to North-East Africa.

The distribution of a third Ethiopian family of rodents (*Octodontidæ*) is particularly interesting, as it is represented in South America by a considerable number of genera, and is not found elsewhere except in the Ethiopian and on the borders between the Ethiopian and Palæarctic Regions. There are four African genera of this family, each with a single species, so that in the Old World the group appears to be in a state of decay. The only light thrown on this curious case of discontinuous distribution is the occurrence of a fossil genus (*Pellegrinia*) allied to the African forms in the Pleistocene beds of Sicily. This indicates that members of this family once had a wider distribution northwards than they now retain.

The Carnivora are well represented in the Ethiopian Region. This is especially the case with the family of civets (*Viverridæ*), only found elsewhere in the Palæarctic and Oriental Regions. Out of a total number of seventeen genera,

three only are found outside this region, and out of the remaining fourteen, six are confined to the island of Madagascar.

Another remarkable fact about the Ethiopian Carnivora is the entire absence of the otherwise widespread family of bears (*Ursidæ*). This group has existed in Europe since the time when the Upper Pliocene beds were laid down, and their remains have been also found in the Siwalik deposits of India, which are possibly of even greater age. It seems, therefore, very strange that the bears should never have reached Africa, when so many of the other genera found in the same deposits have managed to do so.

The Insectivora of the Ethiopian Region are fairly numerous, and show considerable specialization. Out of the six Ethiopian families three are not found elsewhere, and one of the others only extends into the Palæarctic Region as far as Northern Africa. This is the family of elephant-shrews (*Macroscelidæ*).

The bats of this Region present few particular features of interest, belonging nearly all to widely spread genera of widely spread families. Among those that are peculiar the most important is *Epomophorus*, containing eight or ten species of large fruit-eating bats, with long rather horse-like heads, and expansible and peculiarly folded lips. The *Epomophori* seem to take the place, in Africa, of the genus *Pteropus*, which, although represented by several species in Madagascar, and even in the Comoros (which are separated from the mainland by only a comparatively narrow strait), is entirely absent from the African mainland itself.

Finally, among the Primates we have two families of lemurs, one containing only a single species (*Chiromyidæ*) confined to Madagascar, the other (*Lemuridæ*) containing a large number of genera, of which ten are confined to Madagascar, two are found on the mainland of Africa, the other two in the Oriental Region.

The monkeys of the Ethiopian Region, which are entirely absent from Madagascar, belong to two families, both of them shared with the Oriental. The genera, however, seven in number, are all without exception confined to this region.

Summarizing these results, therefore, we find that the Ethiopian Region is characterized by the exclusive possession of ten families of mammals, namely—

Orycteropodidæ (aardvark).	Protelidæ (aard wolf).
Hippopotamidæ (hippopotamus).	Potomogalidæ (river shrew).
Giraffidæ (giraffe).	Centetidæ (tenrec).
Anomaluridæ (spiny-tailed squirrel).	Chrysochloridæ (golden mole).
Lophiomyidæ (crested tree-rat).	Chiromyidæ (aye-aye).

and by the presence of ninety-nine endemic genera.

On the other hand, among a considerable number of families not represented in this region, the following five are all widely spread elsewhere, and may therefore be considered as typical "lipotypes" of the Ethiopian Region:—

Cervidæ (deer).	Ursidæ (bears).
Tapiridæ (tapirs).	Talpidæ (moles).
Castoridæ (beavers).	

Sect. 3.—Subdivision of the Ethiopian Region.

In subdividing the Ethiopian Region into subregions, it must be always remembered that one of the subregions far predominates over the others in speciality and distinctness, and that the remaining subregions all resemble one another more or less closely, and are difficult of separation.

This subregion, which is so distinct from the others, consists of the large island of Madagascar, together with the island groups in its immediate vicinity, viz. the Comoros, the Seychelles, and Amirante to the north, and the Mascarene islands

(Réunion, Mauritius, and Rodriguez) to the east. Whatever other conclusions may be arrived at regarding the best mode of dividing the Ethiopian Region, every authority is, I think, agreed on this matter, the only doubtful point being whether the subregion in question is not well entitled to the full rank of a region.

On the African continent itself a fairly distinct subregion can be recognized, extending all over the forest country of Western Africa from the Senegal river over the whole Congo basin, or perhaps rather further south. The best inland boundary of this subregion would probably be the water-parting between the West African rivers on the one side, and the Nile on the other. There can, at any rate, be now little doubt that the West African fauna extends as far eastwards as the western bank of Lake Tanganyika. Even on the shores of Victoria Nyanza, according to Herr Neumann's (5) recent researches, some typical West African forms are met with; but for the present it will be safer to restrict the West African subregion to the western watershed. The southern or Cape subregion, as defined by Wallace, includes only the country south of a line drawn from Walfisch bay, just to the north of the tropic of Capricorn, to Mozambique. Since the publication of Mr. Wallace's book, however, much additional information has been obtained regarding the distribution of the mammals of Eastern Africa. Many of the animals formerly supposed to be confined to the southern end of the continent, have been shown to extend all through Nyasaland, at least as far north as Kilimanjaro. It will, therefore, be advisable to extend the boundaries of this subregion further north. The boundary adopted in this paper, as will be seen by consulting the map, runs from Angola in the west, along the southern water-parting of the Congo as far as Lake Tanganyika, passing thence to Kilimanjaro, and so on to the Indian Ocean along the Tana river.

The rest of Africa, including the Sahara, the southern portion of Arabia, and North-East Africa, will form a fourth subregion, which, however, does not contain nearly so high a percentage of endemic genera as the other three.

The Ethiopian Region may therefore be divided into four subregions as follows:—

1. The *Malagasy Subregion*, including Madagascar and its adjacent islands.
2. The *West African Subregion*, including the great equatorial forest of Central Africa contained in the basins of the western rivers, from the Senegal to the Congo inclusive.
3. The *Cape Subregion*, including all Africa south of the watershed of the Congo on the West and of the Tana on the East Coast.
4. The *Saharan Subregion*, consisting (if we exclude the Abyssinian plateau) chiefly of desert, or at any rate of a comparatively dry country, including the Sahara, Eastern Africa as far south as the Tana river, and Southern Arabia.

Sect. 4.—The Malagasy Subregion.

The island of Madagascar is separated from the mainland of Africa by the Mozambique channel, which, though only about 250 miles across at its narrowest point, is more than 100 fathoms deep throughout its extent.

For our recent knowledge of the fauna of Madagascar we are chiefly indebted to the great work of Grandidier (3). Unfortunately, up to the present time only the plates of that part which deals with the mammals have been published.

Out of a total number of forty-three genera of mammals found in this subregion, no less than thirty are exclusively confined to it. Of the others, three occur also on the mainland of Africa, and the remaining ten—all of which are bats—are cosmopolitan, or at any rate extend beyond the limits of the Ethiopian Region.

The ungulates are represented in Madagascar by only one form—a peculiar river hog (*Potomochœrus edwardsi*) closely allied to the South African species, but still sufficiently distinct to have earned a title to a separate appellation. With this exception, the ungulates, so numerous and so conspicuous a feature on the African continent, are entirely absent from Madagascar.

The rodents are represented in this subregion by five genera of mice, containing six species, all confined to it.

The Malagasy Subregion possesses several remarkable forms of carnivores, of which the most remarkable, perhaps, is *Cryptoprocta*—a large cat-like animal allied to the civets, but sufficiently distinct to form a separate subfamily of the *Viverridæ*. Belonging to the same family, too, is the fossa, closely resembling the Indian civet (*Viverricula*), and four genera with six species of mongooses, all confined to the island. Of these the most remarkable is *Eupleres*—a form the jaws and teeth of which are so weak and small, that it was at one time thought to belong to the Insectivora. On the whole, out of the seven genera of Carnivora found in the island, six are absolutely peculiar, and the seventh (*Crossachus*) is represented by a mongoose common over the greater part of Africa, and not improbably introduced into the island by human agency.

Among the Insectivora of this subregion even greater specialization prevails. There are seven genera of this order found in Madagascar, all confined to the island. *Geogale*, a small mouse-like animal about which little is known, is said to be allied to *Potomogale*, an aquatic otter-like animal found only in Western Africa. The remaining six genera make up the family *Centetidæ*, the affinities of which are somewhat doubtful, but seem on the whole to approach the Solenodonts, a group confined to the Greater Antilles. The best known of the *Centetidæ* is the tenrec—the largest member of the order, between 12 and 16 inches long, and devoid of a tail. The young of this creature are covered with spines like a hedgehog, but these are lost in the adult state.

The bats of Madagascar, as would naturally be expected, do not exhibit the great peculiarities found among the other orders of mammals. Out of twelve genera only one is confined to the island. The distribution of *Pteropus*, the genus of large tropical fruit-eating bats, often called flying-foxes, is interesting. Five members of this genus are found in the Malagasy Subregion, including two species in the Comoro islands, and although these islands are almost within sight of the mainland of Africa, not a single representative of the true *Pteropus* has yet been obtained on the continent. The strange distributional area of this genus has already been referred to (*Geogr. Jour.*, iv. p. 46). *Pteropus* is mainly confined to the islands of the Indian and Pacific Oceans, and has only one or two exceptional species on the great land-masses. The genus *Emballonura*, belonging to the insectivorous division of the bats, and distinguished, among other characters, by the fact that the tail penetrates the interfemoral membrane and appears free above, has a somewhat similar Oceanic distribution. It is found in Madagascar, and thence eastward as far as Samoa in the Pacific, but never on the mainland of Africa or Asia, although it has recently been obtained by Dr. Anderson in the Mergui archipelago, on islands quite close to the southern part of the Burmese coast.

Finally, among the Primates we reach the culminating-point of the fauna of this strange land. No less than eleven genera of lemurs, which form the lowest of the three divisions into which the Primates are divided, are entirely confined to the subregion.

Outside the subregion there are only five additional genera now in existence, two of them belonging to Africa proper, and three to the Oriental Region.

The lemurs are none of them very large; they are all arboreal animals, spending their lives retired in the forest, and, as a rule, strictly nocturnal. Though allied to the true monkeys, they have none of their vivacity and intelligence; they move but slowly, and have usually very large eyes, which are no doubt necessitated by their nocturnal habits. The lemurs inhabiting Madagascar are divided into two families: (1) the *Lemuridæ*, with ten genera and about thirty-three species, to which family, also, the African and two of the Oriental genera are generally assigned; and (2) the *Chiromyidæ*. The latter family contains only a single genus and species, the extremely anomalous aye-aye, discovered by the traveller Sonnerat in 1780. There are generally examples of this curious animal in the Zoological Society's gardens in London, but, unless especially aroused, they are seldom seen by daylight. Their chief peculiarity is the long, thin, ghost-like middle finger, with which they are said to extract wood-boring insects from their burrows, although their chief food in captivity seems to consist of succulent juices.

Of the extinct mammal-fauna of Madagascar we know as yet too little. Mr. Forsyth-Major (4) has lately described a large lemur (*Megaladapis*) differing considerably from those now inhabiting the island; while remains of two small lemurs and of two species of hippopotamus have been also met with. These remains, together with the bones of a large flightless bird (*Æpyornis*), apparently allied to other Ratite birds, are of a comparatively recent period.

On the whole, however, we cannot but presume that Madagascar originally obtained its animal life from the mainland of Africa. The striking differences between the present faunas of Africa proper and Madagascar are doubtless due to the fact that the great bulk of the existing African fauna is comparatively modern, and came from the Northern continent at the end of the Miocene or the beginning of the Pliocene times, while Madagascar was cut off from Africa before this eruption of Northern forms took place. Madagascar, therefore, appears to contain a sample of the ancient Ethiopian fauna, which has been almost exterminated on the mainland, but had survived here under the protection given by its separation from the adjacent continent. The fauna of the Malagasy Subregion, with that of the rest of Africa, may be summarized by the exclusive possession of—

(1) Five genera of the family *Muridæ*, among the rodents.

(2) Six genera of the family *Viverridæ*, among the carnivores.

(3) One genus (*Geogale*) of the family *Potamogalidae* (shared with the West African Subregion) and six genera making the whole of the family *Centetidæ*, among the insectivores.

(4) One genera (*Chiromys*) alone forming the family *Chiromyidæ*, and ten genera of the family *Lemuridæ*, shared with the African continent and the Oriental Region, among the primates.

Almost equally important is the absence of the following groups:—

(1) The orders *Edentata* and *Ungulata* (except *Potamochœrus*).

(2) The families *Sciuridæ* (squirrels), *Spalacidæ* (blind moles), *Octodontidæ*, *Hystricidæ* (porcupines), and *Leporidæ* (hares), among the rodents.

(3) The families *Felidæ* (cats), *Canidae* (dogs), and *Mustelidæ* (weasels), among the Carnivora.

(4) The Primates, other than the lemurs.

The following table shows the number of Madagascar mammals and their distribution:—

	Ungulata.	Rodentia.	Carnivora.	Insectivora.	Chiroptera.	Primates.	Total.
Endemic	0	5	6	7	1	11	30
African	1	0	1(?)	0	1	0	3
Cosmopolitan	0	0	0	0	10	0	10
Total	1	5	7	7	12	11	43

[N.B.—The "Endemic" genera are those confined to the Malagasy Subregion; the "African" genera are those common to Madagascar and the mainland of Africa; and the "Cosmopolitan" genera are those which range beyond the limits of the Ethiopian Region.]

Sect. 5.—The West African Subregion.

The West African Subregion, as defined above, does not contain nearly so large a proportion of peculiar genera as the Malagasy Subregion. At the same time, twelve out of a total of eighty genera of mammals that are found within its limits are not met with elsewhere. Moreover, we find that as a general rule the genera inhabiting other parts of Africa are here replaced by distinct species.

The Edentata are represented by one genus, *Manis*, the scaly anteater. Of the four known African species three are confined to this subregion.

Of the ungulates only one genus is endemic. This is *Hyomoschus*, a very curious aquatic form, which, together with an allied genus found only in the Oriental Region, forms a peculiar family distantly allied to the deer (*Cervidæ*). Many of the genera of ungulates, however, are here represented by peculiar species. Instances of this are the small hippopotamus (*H. liberiensis*), the red river-hog (*Potamochœrus penicillatus*), the West African eland (*Oreas derbianus*), a peculiar species of wild ox (*Bos pumilus*), and several species of coney (*Procavia*).

The rodents do not present any features of great interest, the only peculiar genera being *Deomys* (allied to *Mus*), recently obtained from the Congo district; and the brush-tailed porcupine (*Atherura*), of which one species is found only in this subregion, and the other two are confined to South-East Asia. Four out of the five known species of the peculiar rodent-genus *Anomalurus*, already referred to, are also confined to the West African Subregion.

Turning now to the carnivores, there are found in the West African Subregion only, two remarkable genera, *Poiana* and *Nandinia*. Of these the former is closely allied to the genus *Prionodon*, a beautifully marked civet-like little animal of the Oriental Region, and the latter is affined to the palm civets (*Paradoxurus*), also found in the Oriental Region, but not in Africa.

There is only one genus of the Insectivora confined to this region (*Potamogale*), already alluded to as being allied to the Madagascan *Geogale*. This much modified form is one of the few members of the Insectivora that has adopted aquatic habits. It is, for a member of the order, of considerable size.

The bats of West Africa, as is usually the case in every land, belong mostly to widespread forms. Out of sixteen genera only two, each containing a single species, are confined to this subregion, while a third (*Epomophorus*) has not been found outside Africa. These three genera all belong to the family *Pteropodidæ*, containing the large fruit-eating bats. A few species of lemurs still survive in the forests of the West African Subregion. They belong to two genera, neither of which are represented in Madagascar. Of these, one (*Galago*) is also found in the

other parts of Africa; the other (*Perodicticus*), containing two species, is met with only in the West African Subregion.

The forests of West Africa are plentifully supplied with monkeys. Most of these belong to the genus *Cercopithecus*, of which, out of about forty species, thirty are met with in West Africa. Another genus, *Cercocebus*, contains four species, all confined to this subregion.

Finally, it is only in these pathless and luxuriant jungles that two man-like apes, the chimpanzee and the gorilla, are to be met with. The gorilla seems to be confined to the Gaboon district, but the chimpanzee extends all over the Congo basin up to the shores of Tanganyika.

These two, together with the ourangs and the gibbons of the Oriental Region, make up the family *Simiidæ*, which in structure is the most closely allied to man of all the Primates.

On comparing the West African fauna with that of the rest of Africa, it will be seen that it is characterized by the exclusive presence of the following forms:—

1. *Hyomoschus* (the water-chevrotain), which, together with *Tragulus* of the Oriental Region, forms the family of *Tragulidæ* of the Ungulata.

2. Two genera (*Malacomys* and *Deomys*) of the family *Muridæ*, and *Atherura* (brush-tailed porcupine), found elsewhere only in the Oriental Region, among the rodents.

3. Two genera (*Poiana* and *Nandinia*) of the family *Viverridæ*, among the Carnivora.

4. *Potamogale*, among the Insectivora.

5. Two genera of fruit-eating bats (*Leiponyx* and *Trygenycteris*).

6. *Perodicticus*, a genus of lemurs, and *Cercocebus*, *Gorilla*, and *Anthropopithecus*, among the higher monkeys.

The West African Region is further characterized by the absence of the following families, well represented in other parts of Africa: *Orycteropodidæ* (aardvark), *Giraffidæ* (giraffes), *Equidæ* (zebras and wild asses), *Rhinocerotidæ* (rhinoceroses), and *Leporidæ* (hares).

The following table shows the number of genera in each order and their distribution:—

	Edentata.	Ungulata.	Rodentia.	Carnivora.	Insectivora.	Chiroptera.	Primates.	Total.
Endemic	0	1	2	2	1	2	4	12
African	0	11	10	2	0	1	4	28
Cosmopolitan	1	6	8	9	3	13	0	40
Total	1	18	20	13	4	16	8	80

Sect. 6.—The Cape Subregion.

This subregion, when extended so as to include the whole country as far north as Angola on the west, and up to the Tana river on the east, is on the whole, after the Malagasy, the most distinct of the four subregions, since it possesses nineteen endemic genera out of a total of ninety-one. Furthermore, it contains a greater range of temperature and humidity than the other subregions, for, while in Natal and Mozambique tropical forest conditions prevail, giving the fauna a certain resemblance to that of West Africa, in Cape Colony itself a temperate and fairly dry climate is found. Again, in Namaqua-land, to the north-west of Cape Colony, we meet with an open, dry, hot, desert country, the conditions of which closely

approximate to those of the Saharan Subregion. The distinctness of this subregion, apart from the mammals, is strongly marked by a very remarkable flora, as well as by the exclusive possession of many forms among the other orders and classes of the animal kingdom. Among the Edentata, besides the scaly anteater (*Manis*), of which one species extends as far south-east as the Transvaal, there is also found the aardvark (*Orycteropus*), an animal characteristic of South Africa, though also occurring in East Africa as far north as the upper Nile basin. The relationships of this creature are very obscure, but the recent discovery of remains of a closely allied fossil form in beds of lower Pliocene age in the island of Samos, in the Ægean Sea, shows that the aardvark, like so many other African animals, has migrated southwards from the Palæarctic Region.

The greater number of the genera to which the numerous antelopes of the Cape Subregion belong, extend northwards into the Saharan and even into the West African Subregion, although the species of the Cape Subregion are in many cases distinct.

Among the distinct species may be mentioned the hartebeeste (*Bubalis caama*), the spring-bok (*Gazella euchore*), and the sable antelope (*Hippotragus niger*). The two gnus (*Connochætes*) and the pallah (*Æpyceros*) are confined to this Subregion. To the portion of this Subregion south of the Zambesi are restricted two of the African horses, the quagga (*Equus quagga*), now said to be extinct, and the mountain zebra (*Equus zebra*), which is fast approaching the same condition. But Burchell's zebra (*Equus burchelli*), under various slight modifications, occurs in suitable localities throughout the whole subregion.

The so-called white rhinoceros (*Rhinoceros simus*), which is now only existing in two small districts of Mashonaland and Zululand, was formerly abundant in the Cape Colony and the Transvaal, but has never been met with north of the Zambesi.

Five out of the eighteen genera of rodents found in this subregion are endemic. Two of these belong to the mouse family (*Muridæ*), and two more to a burrowing family (*Spalacidæ*); the fifth (*Petromys*) belongs to the family *Octodontidæ*, which the Ethiopian shares with the Neotropical Region.

The South African Subregion, however, is especially remarkable for the large number of peculiar genera of Carnivora. Five of these genera have been formed for the reception of a number of small animals allied to the Indian mongoose. Another, for which a separate family has been created, contains only the aardwolf (*Proteles*), an animal nearly allied to the hyenas, but with very small, almost rudimentary teeth, and a heavy mane of long hair. It is nocturnal, and feeds principally on carrion, being too weak to attack other living animals. The *Otocyon*, or Cape hunting-dog, which constitutes another peculiar genus, is remarkable for having a greater number of molar teeth than any other mammal. Owing to this, it has been regarded by Professor Huxley as the most primitive of all existing members of its family. Out of the six genera of Insectivora found in this subregion three are endemic. Of these the most interesting is the genus *Chrysochloris*, which forms a distinct family, and comprises no less than eight species. These animals are sometimes known as "golden moles," owing to the brilliant metallic lustre of their fur. They are in some respects allied to the *Centetidæ*, a family mentioned above as confined to Madagascar; but they are modified for a burrowing life, and externally resemble the moles. Neither of the two remaining orders, the bats and the monkeys, is represented by peculiar genera in the Cape Subregion. This, however, is quite what one would expect, as members of these two orders are essentially forest-loving in their habits, and this subregion consists chiefly of sparsely wooded and arid districts.

On the whole, therefore, the Cape Subregion will be found to be characterized,

as compared with other parts of Africa, by the exclusive possession of the following forms :—

1. *Connochætes* (the gnus), *Pelea* (the rhébok), and *Æpyceros* (the pallahs) among the antelopes.

2. *Pachyuromys* and *Mystromys*, genera of *Muridæ*; *Bathyergus* and *Myoscalops*, genera of the burrowing *Spalacidæ*; *Petromys* of the *Octodontidæ*, among the rodents.

3. Five genera of mongooses, belonging to the family of *Viverridæ*; *Proteles*, the only representative of the family *Protelidæ*; *Otocyon* (the Cape hunting-dog); and *Pœcilogale* (a small weasel), among the Carnivora.

4. *Rhynchocyon*, of the *Macroscelidæ*; *Myosorex* (a shrew); and the *Chrysochloridæ* (golden moles), among the Insectivora.

The following table, showing the distribution of South African genera, is constructed on the same plan as that of the other subregions.

	Edentata.	Ungulata.	Rodentia.	Carnivora.	Insectivora.	Chiroptera.	Primates.	Total.
Endemic	0	3	5	8	3	0	0	19
African	1	15	6	3	0	2	4	31
Cosmopolitan	1	8	7	9	3	13	0	41
Total	2	26	18	20	6	15	4	91

Sect. 7.—The Saharan Subregion.

The Saharan Subregion, as its name implies, is essentially a dry and desert district. As here regarded, in addition to the Sahara proper, it includes the southern part of Arabia and Somaliland, both of which are distinctly arid countries. The only part of the subregion where there is much rainfall is in the Abyssinian highlands and the country surrounding such isolated mountains as Kenia. In consequence of these facts, and also in accordance with the fact that the subregion is conterminous for so long a distance with the Palæarctic Region, the number of endemic genera of the Saharan Subregion is extremely small, being only seven out of a total of eighty-five—that is, 8% as compared with 21% in the South African, and 15% in the West African Subregion.

Of recent years a considerable number of new forms, especially of antelopes, have been obtained from Somaliland, a country which, up to a few years ago, was quite unknown, and it is quite possible that eventually the "unknown Horn of Africa" will be found to possess a fauna sufficiently distinct from the rest of the continent to be separated as another subregion. But for the present, until our knowledge is widened a little more, it will be best to keep Somaliland in the Saharan Subregion.

The most characteristic feature of the subregion is, perhaps, the large numbers of antelopes. These, as a rule, are specifically distinct from those of the Cape Subregion. Among them may be mentioned Swayne's hartebeste (*Bubalis swaynei*), Hunter's bontebok (*Damaliscus hunteri*), three species of *Oryx* (*O. beisa* from Abyssinia and Somaliland, *O. beatrix* from Arabia, and *O. leucoryx* extending from Senegal to Nubia), and a distinct species of kudu (*Strepsiceros imberbis*), which inhabits the subregion from Somaliland as far south as the Tana. This subregion is also the head-quarters, too, of the gazelles, at least twelve species out of a total of twenty-three being found there.

Three genera of antelopes are endemic; these are the dibatag (*Ammodorcas*

clarkei), and the gerénuk (*Lithocranius walleri*), both found in Somaliland, and remarkable for their very long necks, by means of which they are enabled to reach down branches of trees from a considerable height. The head and way of feeding of both these gazelles are giraffe-like, as has been described by Captain Swayne.

The third is the addax antelope, which is found throughout the Sahara, and extends into Arabia.

The rodents are well represented in this subregion, but there are only three peculiar genera—*Lophiomys*, *Heterocephalus*, and *Pectinator*.

Lophiomys, a curious crusted rodent, is mentioned above, and forms a distinct family.

The remarkable little animal *Heterocephalus* is almost entirely hairless, and apparently lives underneath the ground, burrowing in the soft sandy soil of the desert. It was originally obtained by the celebrated traveller Rüppell in Abyssinia, and has since been brought from the interior of Somaliland by Mr. Lort Phillips.

The third endemic genus, *Pectinator*, is also from the coast of Somaliland and Abyssinia. It was first obtained by Captain Speke, and named by Blyth after its discoverer.

The Saharan representatives of the Carnivora, Insectivora, and bats are almost all widespread forms, and present no features of special interest. Among the monkeys, however, we find one peculiar genus—this is *Theropithecus*, containing two species of terrestrial baboons, which inhabit Abyssinia and the Galla country.

The other genera of African monkeys are fairly represented here, though by no means so abundantly as in the West African Subregion.

The Saharan Subregion, therefore, is characterized by the exclusive possession of the following genera:—

(1) *Ammodorcas*, *Lithocranius*, and *Addax* among the antelopes.

(2) *Lophiomys* (forming a distinct family), *Heterocephalus*, and *Pectinator* among the rodents.

(3) *Theropithecus* among the Primates.

The following families, found in other parts of Africa, are absent from this subregion: *Tragulidæ* (chevrotains), *Protelidæ* (aardwolf), *Potamogalidæ* (river-shrews), *Centetidæ* (tenrecs), *Chrysochloridæ* (golden moles), *Chiromyidæ* (aye-ayes), and *Simiidæ* (the anthropoid apes).

The following is the summary of the mammals inhabiting the Saharan Subregion:—

	Edentata.	Ungulata.	Rodentia.	Carnivora.	Insectivora.	Chiroptera.	Primates.	Total.
Endemic	0	3	3	0	0	0	1	7
African	1	15	8	3	0	1	4	32
Cosmopolitan	1	9	12	7	3	14	0	46
Total	2	27	23	10	3	15	5	85

Sect. 8.—Past History of the Ethiopian Region.

Up to the present time palæontology has afforded us little assistance in tracing out the past history of the African mammal-fauna. With the exception of a few still surviving species found in a semi-fossil condition in caves, the only fossil mammal hitherto obtained from the Ethiopian Region is a form named by Owen *Tritylodon*, the remains of which were discovered in the Karoo beds of Basutoland, in South Africa. This formation is of Mesozoic age, and seems to correspond to the

Trias of Europe. Near Stuttgart, also, in beds of the Trias age, another specimen closely resembling that of South Africa has been obtained. *Tritylodon* belongs to a group which was apparently allied to the modern marsupials, and many somewhat similar forms have been found in other Mesozoic beds in Europe and North America.

The only conclusion to be drawn from this is, that before the commencement of the Tertiary epoch the whole world was, so far as is at present known, inhabited by small insignificant mammals distantly allied to the marsupials, which at present are restricted to Australia and South America. Besides *Tritylodon*, the only fossil mammals hitherto known, from the Ethiopian Region, are those which have been described by Grandidier (3) and Forsyth-Major (4) from Madagascar, as mentioned above.

The resemblances between the faunas of the Oriental and Ethiopian Regions have been noted and commented on by many writers; Mr. Allen is even disposed to join the two regions into one realm. The number of prevailing genera, however, common to these two regions, and not found in the Palæarctic Region, is very small, the total being, as was pointed out in the first article of this series, only eight, and of these one (*Mellivora*) has since then been recorded by Büchner (2) as occurring in the Trans-Caspian district, and is therefore also Palæarctic. Of the other seven, four have been found, in a fossil state, in various parts of the Palæarctic Region. These are—(1) *Manis* (the scaly anteater), from the Pliocene of Samos; (2) *Rhinoceros*, which existed in various parts of Europe from Miocene up to Pleistocene times; (3) *Elephas*, which first appears in Pliocene times, and extends to late Pleistocene in Europe; and (4) *Viverra*, which commences earlier than the others, and also survived until Pliocene times in Europe. The three remaining genera common to India and Africa, but not hitherto found in fossil state in the Palæarctic Region, are—*Golunda* (a rat), *Atherura* (brush-tailed porcupine), and *Nycteris* (a small insectivorous bat).

It is quite possible that these animals may eventually be discovered in the European Tertiaries. Besides this, the remains of a considerable number of the now endemic African genera have been found fossil in Europe. The list of these is instructive, and points almost unquestionably to the conclusion that Africa has been gradually peopled by successive inroads of animals from the North.

In the Eocene beds of Europe the still existing genera are few in number; but the lemurs, and many of the more primitive forms of the Carnivora, such as form the present fauna of Madagascar, abound. It is, therefore, probable that the separation of Madagascar from the mainland of Africa took place at about the close of the Eocene period. During the Miocene and lower Pliocene times in Europe, a large number of new genera appear for the first time, the bulk of which still survive in Africa and India, though extinct or almost driven out of the Palæarctic Region.

Examples of such genera are—*Orycteropus*, the ardvaark; *Manis*, the scaly anteater; *Rhinoceros*; *Hyomoschus*, the water chevrotain (probably identical with *Dorcotherium*, a fossil form); *Giraffa*; several genera of Antelope; the Porcupine; the Squirrel; *Felis*; *Hyena*; *Viverra*; *Herpestes* and even the higher Monkeys.

It must have been during this period that broad land-connections existed between Europe and Africa, by means of which the Dark Continent became peopled by its present fauna.

In the succeeding Pliocene times in Europe, although a number of the more distinctly African forms still survive, there begin to appear certain genera, such as those of the deer family (*Cervidæ*), *Ursus*, the bear, and others which have never reached Africa at all. This seems to show that Africa was, at the commencement

of this period, cut off from the Palæarctic Region by a sea occupying approximately the Saharan desert of to-day.

List of Literature referred to.

(1) Balfour, J. B.—"Botany of Socotra" (Mammals, p. xxx.). *Trans. Roy. Soc. Edin.*, xxxi. 1888.

(2) Büchner, E.—"Ueber das Vorkommen der Mellivora indica, Kerr, im Transcaspi-Gebiet." *Notes Leyd. Mus.*, xv. p. 99.

(3) Grandidier.—"Histoire Physique, Naturel et Politique de Madagascar," vol. x. *Mammifères*, by Milne Edwards and Grandidier, 1890, pls. 123, 172 (all Lemurs, no text).

(4) Major, C. I. Forsyth—"On Megaladapis madagascariensis, an extinct gigantic lemuroid." *Proc. Roy. Soc.*, 1893, p. 176.

(5) Neuman, B.—"Bericht über seine Reisen in Ost und Central Afrika." *Verhandl. Gesellsch. Erdkunde Berlin*, 1895 (p. 24 in separate copy).

(6) Thomas, O.—"On some specimens of Mammals from Oman, South-East Arabia." *P.Z.S.*, 1894, p. 448.

THE MARSHALL ISLANDS.*

By Dr. STEINBACH.

The Marshall group consists of two nearly parallel series of islands, running from N.N.W. to S.S.E., which are named by the natives Ratak ("Islands towards the Dawn") and Relik ("Islands towards the Sunset"). Of a sea-area larger than Germany, about 176 square miles, according to Dr. Steinbach's estimate, are occupied by the thirty-four islands. All are of coral, and most are atolls, though there are a few single islands also. Existing maps are still very incomplete, especially as regards the atoll Arno. In connection with the theory of the formation of coral islands, it is noteworthy that the side of the Atolls which is exposed to the prevailing wind, and therefore to the heaviest surf, has always the greatest number of islets. The number of these in the separate atolls varies greatly, as does the size of the latter. The height of the islets rarely exceeds 3 to 12 feet, but in a few places, as, *e.g.*, on Ligieb, dune-formations of coral sand rise to a height of 40 feet.

Of the Relik group the most important are Yaluit (the seat of government), Ebon, and Namvik. The second of these is the most southern of the group, and possesses a fairly thick layer of *humus*, supporting a rich vegetation. It was formerly the seat of the Hawaiian Mission, and has about 1000 inhabitants. In the Ratak group, Mejem has a population of about 1200, and (in part) a well-tilled and fertile soil. Eastward of it lies the atoll Arno, likewise fairly well peopled and fertile, while the atolls Milli, Aur, and Maloelap are also noted for good cultivation and luxuriant growth of trees. Since 1877 extensive plantations of cocoanuts have been made on Ligiep, in the north, the half-caste inhabitants of which possess good boats and even small ships. The most northern islets are inhabited by large colonies of sea-birds, but the guano has not proved worth exploiting. They are only visited occasionally in quest of turtle and the feathers of the frigate-bird.

The climate of the Marshall islands is, for a tropical climate, comparatively favourable to Europeans. They are free from swamps, but the continued high

* Abstract of paper read at the Berlin Geographical Society, June 8, 1895.

temperature and the moisture of the air render them dangerous for Europeans with heart or lung affections. Besides heart and kidney disease, dysentery and rheumatism (both of the muscles and joints) are not uncommon. Observations extending over three years gave the mean temperature as 80·6° Fahr., the extremes being 93° and 71°, but the difference between the means for the hottest and coldest months (*i.e.* January or February and July or September) only about 1·5°. The rainfall is pretty evenly distributed through the year, and is quite excessive (177 inches). It is only in January and February that a comparatively dry period can be expected. A cloudy sky is frequent, and the number of really hot days only about six in the year. The north-east trades blow from December to April, becoming rather easterly or south-easterly from March to November. Calms or violent south-westerly storms occur chiefly between August and November. There being no springs, a supply of water is collected in tanks or cisterns. The useful plants include the coconut palm, bread-fruit tree, and *Pandanus odoratissimus*, the sap of which last is rich in sugar. The cultivation of plantains has much increased of late, besides which several kinds of arums, the South Sea arrowroot (*Tacca pinnatifida*), and a mangrove which supplies a black dye, are grown. Some European vegetables thrive, and guavas, figs, citrons, and anonas do well; but tea, coffee, cacao, etc., cannot be grown at all.

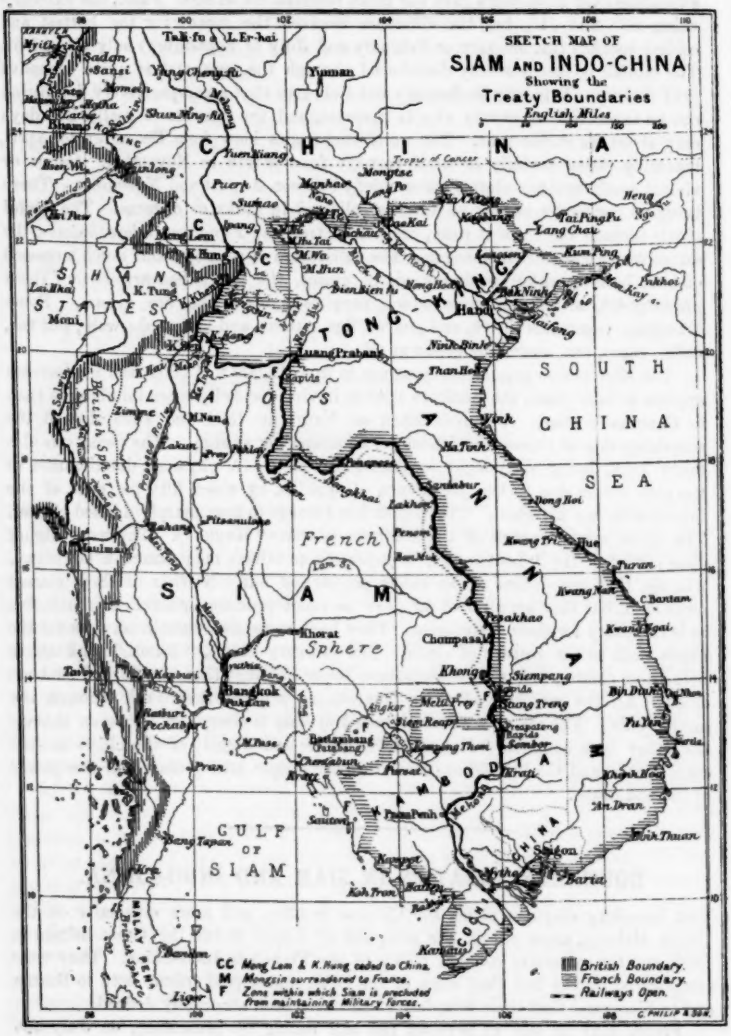
The Micronesian population amounts to from 12,000 to 13,000, and no decrease appears to take place, the northern islands having decidedly more inhabitants than in Chamisso's time. A census taken on Nauru in 1891 and 1893 showed the surprising rate of increase of fifteen per thousand per annum. The density is also fairly high, being sixty-eight to the square mile. A physical deterioration of the race seems due to the prevalence of syphilis, by which fifty per cent. of the inhabitants are attacked. The population belongs to four sharply defined classes. The great mass consists of the common people ("Kayur"). The next higher class is that of the "Leataketak," comparable to village magistrates in Germany, who see that the orders of the chiefs are carried out. Neither of these classes owns land, but they are allowed to grow as much produce or catch as much fish as is necessary for their sustenance. They have to perform certain services for the chiefs, such as the cutting of *copra*. The ordinary chiefs, "Burak," rank above both these classes, and they often possess larger holdings than the "Iroj," or head chiefs. All the members of these four classes acquire their rank through the mother only. The son of a woman of the Iroj class is always an Iroj, even though the father be a common "Kayur." The power and dignity of the chiefs is still considerable, and the judicial observance of the people still gives them the power of life and death.

BOUNDARY TREATIES IN SIAM AND INDO-CHINA.

The boundary disputes along the Chinese frontier, and more especially on the Upper Mekong, arose out of the conquest of Upper Burma by Great Britain in 1885, and the expansive colonial policy of the French in Indo-China. They were complicated by the fact that some of the Shan states paid tribute both to Burma and to Siam, and that their boundaries had never been accurately defined.

France may be said to have set the ball rolling by presenting, on July 20, 1893, an ultimatum at Bangkok, in which she claimed the surrender of the whole of the Siamese territories lying to the east of the Mekong, as far as the Chinese frontier. Siam after a time conceded all that was demanded. By the treaty of October 30 (November 25), 1893, France secured the whole of the territory to the

east of the river named. Siam undertook to maintain no armed boats on the river or on the Grand lake, to withdraw her garrisons or military establishments from the provinces of Battambang and Siem Reap, and from within a zone 25 kilomètres



(15·5 miles) broad, extending along the right bank of the Mekong. France, moreover, was authorized, in the interests of navigation and of commerce, to establish coaling-stations on the right bank of the river, and to appoint consuls to Khorat, Muang Nan, and other places.

The area of the districts within which the authority of the King of Siam is curtailed in this manner amounts to 20,000 square miles.

The claim advanced by France on the strength of this treaty brought her into conflict with British claims on the Upper Mekong. After futile discussions, the governments concerned, on November 25, 1893, agreed to the creation of a neutral zone or "buffer state" on the Upper Mekong; but when it became evident that no settlement could be arrived at in this way, fresh negotiations were entered upon, and these resulted in a "Declaration" signed at London on January 15, 1896. This "declaration" should be interpreted in the light of the notes of Lord Salisbury and Baron A. de Courcel which accompany it, and it will then be seen that Siam has not been dismembered, as was at first supposed, but that the arrangements made are intended to promote the "security and stability of the kingdom of Siam."

Siam henceforth occupies a unique position among independent states.

Its central section (84,600 square miles) includes the basins of all rivers which drain into the Gulf of Siam from Bang Tapan to Pase, as also the territory to the north of the basin of the Menam, and situated between the Anglo-Siamese frontier, the Mekong, and the eastern watershed of the Me Ing. Within this, the most populous and productive portion of Siam, the two powers undertake "that they will not operate by their military forces, except so far as they may do it in concert for any purpose that may be required for maintaining the independence of Siam." Nor will they seek to acquire within that area any privileges or commercial facilities which are not extended to both of them.

As to the remainder of Siam, the rights of the king are carefully guarded, but no such limitations, as above described, are imposed upon the contracting powers with respect to them. France not only retains the 25-kilomètre belt along the Mekong, and other privileges secured by her treaty with Siam, but the whole of the eastern portion of the kingdom, including Khorat (80,100 square miles), is assigned to her as a sphere of independent action; whilst Great Britain enjoys a similar freedom with respect to the Siamese territories lying to the west. These include a portion of the basin of the Salwin (8800 square miles), and the whole of the Siamese portion of the Malay peninsula to the south of Bang Tapan (45,500 square miles).

Mongsin (1600 square miles), which was occupied by British troops in May last as a portion of the Kiang Kheng states, has been surrendered to France, and the Mekong henceforth forms the boundary between the British Shan states and French Indo-China.

The other treaty boundaries shown on the accompanying map are as follows:—

1. The Anglo-Siamese boundary, according to the treaty of October 3, 1893.

2. The Anglo-Chinese boundary, according to the treaty of March 1, 1894. By this treaty the Shan states of Mong Lem and Kiang Hung were ceded to China, but the cession was made conditional upon China not surrendering these states to a third party. This was supplemented by a convention signed at Tientsin on Sepember 6, 1894, which provides for a junction of the Burmese and Chinese lines of telegraph between Bhamo and Momein.

3. The boundary between China and Tongking, as defined in the convention of June 20, 1895. By this arrangement China surrendered Muang Hu and Muang Hu Tai, which were at least nominally portions of the state of Kiang Hung. France secured also important commercial advantages by this convention. Lung-chau, Sumao, and Hoi-han (near Mongtse) are opened to foreign commerce; the Mekong and its tributary the Loso are opened to navigation; provisions are made for the extension of railways and telegraphs; and the mines in Kwang-tung, Kwang-si, and Yun-nan are thrown open to French enterprise—not, however, to the exclusion of other nationalities.

FROM YUN-NAN TO BRITISH INDIA.

By PRINCE HENRY OF ORLEANS.

[By the courtesy of M. Maunoir, the Secretary of the Paris Geographical Society, we have received an advance proof of the communication addressed to that Society by Prince Henry of Orleans, on his recent remarkable journey from Talifu (Yun-nan) to Sadiya (British India).]

About the middle of June (1895) we left Talifu, our object being to continue the exploration of the Mekong.

During our stay at Tali we were able to rearrange our caravan. We have an excellent head muleteer, a serious man, from whose mouth we never heard an oath or a complaint (a rare thing in China). Our interpreter is a Christian of twenty-eight years, a Chinese, with whom we converse in Latin. To say that to listen to us would not have grated on the ears of Cicero would be an absurd pretension; but dog-Latin or not, we understand one another, and that is the principal thing. Joseph—that is the name of the interpreter—is a devoted man, for whose services we have constantly had to be thankful. Some *mafus* completed the party, and our two Annamites continued to follow us. We struck out in a westerly direction. Two passes, one of which is over 3000 mètres (9843 feet), but of easy access, having been crossed, we arrived at Yunlong-Chu. From thence to Feilong-Kiao, where the Mekong was crossed upon a fine bridge, the last in the north until arriving at Chiamdo.

At Feilong-Kiao the people told us that there was only a route upon the left bank; that the right bank was impossible for mules to follow, and also that it was inhabited by savage and independent tribes. This was tempting for us. They told us of an attractive route leading to Lao, a village three days from Feilong-Kiao upon the right bank. Let us go as far as Lao; this will be so much gained, and we shall easily see if we can continue.

Starting again, we marched stage by stage, advancing, thanks to the more or less correct information, as far as the valley of the Salwin. Before reaching this valley we were already obliged to adopt those methods of travelling which, as far as Tseku, tended to render our march very slow. Our men were obliged to transform themselves into road-menders. Each day it was necessary to unload the baggage and to work at the road. We considered ourselves fortunate when this operation was not renewed more than twice a day. The chief muleteer in front, pick in hand, directed the work, which was very trying, and from our old party we should never have expected the exertions now put forth by our men. The track repaired or made, they led the mules, but to add to our misfortune, we had a period of rain, the ground was slippery, and the animals kept their footing with difficulty, and frequently fell. I remember, among others, one day, when at the same place, we saw five mules with their loads fall in succession from a height of 30 mètres (98 feet). It was necessary that everybody should set to work to raise the pack-saddles, to rearrange and fasten them on again, then to lead the animals, which after these formidable falls we found tranquilly browsing at the bottom of the ravine, as if they were made of indiarubber. All this work in a pelting rain. There were still some hours of marching in order to reach the hut where we were to spend the night, every one being continually obliged to pick up the fallen loads; then the caravan separated into many parts, one of which mistook the road. I pitied our men. Really this was too much "guigne." It was enough (pardon the vulgar word, which expresses the thing well) to make one savage. At the first

village after these hard days some men left us, but we were able to replace them by natives.

[The want of precise information made them take fifteen days to reach, upon the right bank of the Mekong, a point which is only two days to the north of Feilong-Kiao; but they were thus able to follow up the left bank of the Salwin for several days.]

On July 9 we were again on the right bank of the Mekong, which we followed as far as Into, reaching this place on August 11. I cannot say that the route is practicable for mules. We got through, and that is all. Besides the daily work of filling up or widening the track in the line of march, we were on certain days completely stopped, while one party of our men made a path through loose soil, which kept crumbling down into the river. Mules are good mountaineers, and have the advantage of not being given to dizziness, otherwise we doubtless should not have preserved one. One day one of our animals fell into the river. By chance the men were able to stop the load (two of our trunks) before it reached the water, but the animal itself, carried away by the current, crossed the river and landed lower down on the left bank. Some villagers were able to chase it and send it back to us by the same way.

During this part of the journey along the right bank of the Mekong, we passed through some very interesting tribes—Lamajen and Lissus. Advancing but slowly, and sleeping almost every night in one of their villages, we were enabled to see them very closely, to be present at their dances, and gather interesting particulars concerning their manners.

[These tribes, who appeared rather timid, made no difficulty about the travellers proceeding; but one evening they had to take up their arms to repulse an attack which appeared to be imminent. The Lissu villagers were frightened, and wished to massacre them, but during the night everything quieted down.]

The Lissus and Lamajen on the Mekong are very timid. The unfortunate people are continually the victims of the incursions of the independent Lissus of the Salwin, who are dangerous brigands. In nearly every village we were told of a band which had come from the other side of the mountain two or three days previously, and had taken away cattle, and even some men, who, if not ransomed by their friends, would be reduced to slavery. I asked the villagers why they did not do the same to their enemies, and in their turn go and pillage them. The answer was, "They are stronger and better armed than we are." To this reply there was nothing to say.

[Generally the travellers were well received; sometimes the Lissu bards, accompanying themselves on a guitar, sang impromptu songs in honour of the "great men" come from afar. This part of the journey passed off well, except that Lieut. Roux had to deplore the loss of his theodolite and his hypsometer.]

At Into we were opposite Hsiao-Wei-si, where a French missionary resides, Father Tinlet, whom I had already had the pleasure of meeting at Szu-Chuan, whilst on my journey with M. Bonvalot. He told me that we could not go as far as Tseku with the animals, as, before reaching that locality, there are perpendicular rocks which we could not pass over with the caravan, even though we carried out our usual operations. Two days above Into we were, therefore, obliged to cross the Mekong—a dangerous passage in small canoes, shot through the middle of the rapids. We got over, however, without accident.

On August 19 we recrossed the Mekong by a rope bridge, upon which men and animals slid in turns, attached to a small wooden seat, and thus arrived at Tseku.

Tseku, a station of the Tibetan mission, is inhabited by two missionaries,

from whom we received the most hearty welcome possible. Although under the jurisdiction of Yun-nan, we were in the country of the Tibetan tongue. Some days previously we had finished the exploration of the Mekong in China.

Beyond this point, the course of this river has been laid down by Messrs. Cooper, Gill and Mesny, Count Széchenyi, the Pundit A. K., and the missionaries, as far as Chiamdo. To the north of this point, M. Bonvalot and I, and Rockhill have crossed it. In order that the course may be entirely known, it only remains to survey one part of it from the other side, from the Degue up to its sources. We had, therefore, finished our mission, strictly speaking, and accomplished the object which we had planned. The thing was to return.

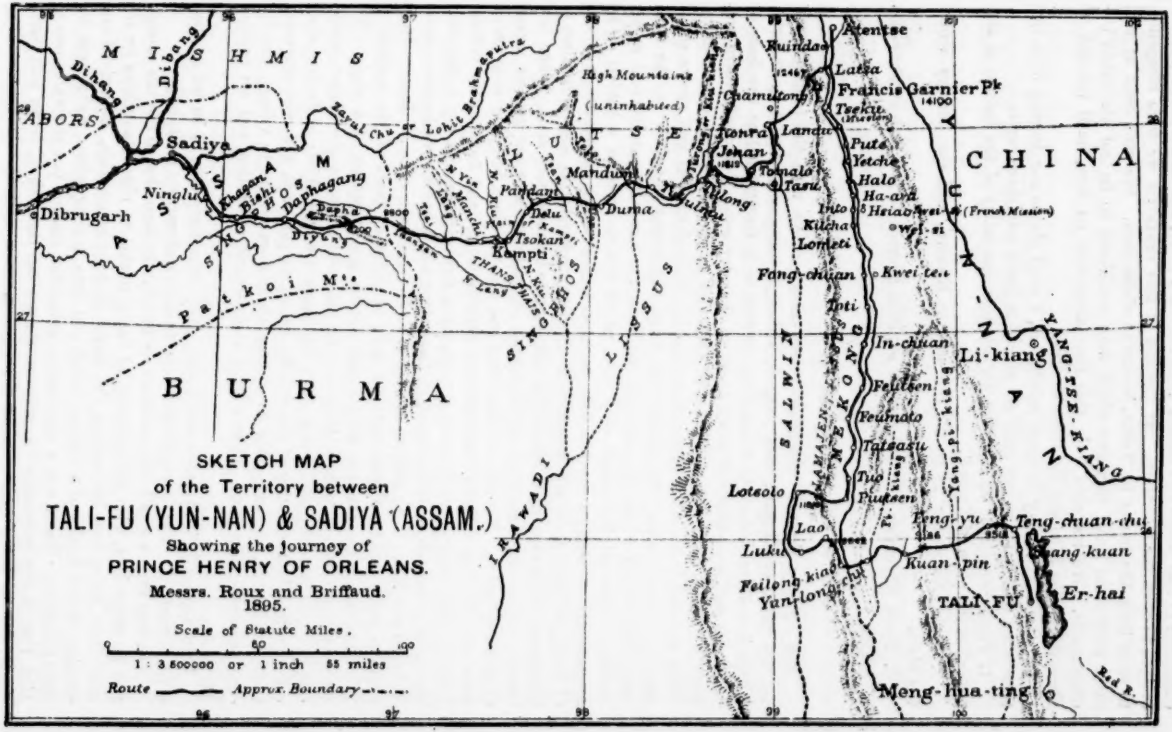
[The stay at Tseku was prolonged, the Prince of Orleans having taken fever and neuralgia. During the leisure time of his convalescence, whilst Lieut. Roux pushed forward as far as Atentse, in order to fix a point astronomically for the end of the journey, he gathered, with the aid of the missionaries, a great deal of information about the Tibetans, the Lissus, and the Massas of this region. He obtained from these latter some books of sorcerers' prayers, written in hieroglyphics, and made them translate them in his presence, which he believes had not previously been done. Various considerations made the travellers give up the idea of going to the province of Sarong, their goal now being India, which they tried to reach by the most direct route possible.]

We endeavoured to find our nearest possible way to the Zayul Chu, in order to seek to settle definitely the problem of the Salwin and the Irawadi by crossing the upper branches of the latter near their source. It was with this object that, on September 10, we left Tseku. We had sent back to Talifu the greater number of our mules, with all our Chinese muleteers, our collections, and all that was not absolutely necessary to us (by the great route *viâ* Wei-si and Likiang). We only retained what was strictly necessary, and about fifteen mules. Beside our interpreter Joseph, two Chinese, and the Annamites, our party comprised twenty-six men of Tseku or its environs. These are people dressed in the Tibetan style, and speaking Tibetan among themselves; but most of the people one finds around Tseku, being a mixture of different races, are polyglots. Nearly all speak Chinese; some the Mosso, the Lutse, and the Lissu. The greater number are Christians. These men will act as porters and *mafus* at the same time. They engaged to follow us wherever we should desire, and as long as we should wish. We, on our part, engaged to send them back to their own country by the way that to us should appear the easiest and least dangerous.

[But the travellers have little information: beyond the Salwin there is a great river called Kiukiang, the paths are very bad, the inhabitants are savages and live on trees. This is all that they could learn about this country, which separates China from India.]

From September 10 to 19, we passed from the valley of the Mekong into that of the Salwin. The pass is high, 3800 mètres (12,467 feet). A lofty peak which commands it received from us the name of Francis Garnier. During this time it rained almost continually. The animals were worn out, and it was necessary to make nearly all the journey on foot. We were still in a country comparatively well known. Some missionaries have come into these parts bordering on the Salwin. We found ourselves in the midst of the Lutse people, who received us very well. The crossing of the river was easily accomplished in small canoes. We were between the lamasery of Chamutong, from which presents were sent to us, and Tasu, where Father Dubernard used to be.

A range with a pass of 3600 mètres (11,812 feet) rises between the Salwin and an affluent to the right of it. It would have necessitated a long detour for us to


SKETCH MAP
of the Territory between
TALI-FU (YUN-NAN) & SADIYA (ASSAM.)
Showing the journey of
PRINCE HENRY OF ORLEANS.
Messrs. Roux and Briffaud.
1895.
Scale of Statute Miles.
0 50 100
1 : 3 500000 or 1 inch 55 miles
Route
Approx. Boundary
MISHMIS
ABORS
BURMA
CHINA
Sadiya
Dibrugarh
Dihang
Dibang
Lohit Brahmaputra
Zayul Chu or Lohit Brahmaputra
High Mountains (uninhabited)
Mandum
Duma
Tsokan
Kampti
Daphagang
Ninglung
Pashu
Patkoi Mts
Singphos
Hkamti Long
Hkamti Long
Ruinda
Latsa
Francis Garnier Pk
14100
Tsaku
Chamutong
Tsonra
Landa
Jehan
Tsomalo
Tasu
Putu
Yetche
Halo
Ha-ara
Hsiao Weixi (French Mission)
Into
Kucha
Lometi
Fang-chuan
Kwei te
Toti
In-chuan
Li-kiang
Yang-tse-kiang
Feitsen
Feumato
Tatsaszu
Tuo
Piutsen
Lotsoto
Lao
Teng-yu
Teng-chuan-chu
Luku
Kuan-pin
Feilong kiao
Yan-long-chu
TALI-FU
Er-hai
Meng-hua-ting
Red R.
Irawadi
Salween
Mekong
Yangtse Kiang
Lisus
Nmai Hka
Taron
Tsangpo
Pandam
Delu
Kamti
Thang Hills
Kyang
Mountains
Kyang
Kyang
Kyang

endeavour to find where this stream joins the main river, and we should have been obliged to cross the mountain. At the foot of this mountain we were compelled to send back the mules to Tseku, in charge of two men. We sent back at the same time some small baggages which were considered to be not absolutely indispensable. We travelled from this time altogether on foot, until the end of December—that is to say, for three months.

In order that it may be more intelligible, I shall divide our journey from the time when we left the mules until our arrival in India into three parts:—

1. From September 22 to November 18, from the valley of the Salwin to the arrival at the plain of Khamti.

2. From November 18 to 25, the stay at Khamti, and the journey across the plain.

3. From November 25 to December 16, from Khamti to the first large village of Assam.

1. *From the Salwin to Khamti.*

The country through which we passed after parting with the mules as far as the plain of Khamti, very rugged, although its general aspect is uniform. There is nothing but steep mountains, covered with forests, and at the base of which are swollen torrents or small rivers of clear icy water. Of roads there are, correctly speaking, none. We scaled the sides of the mountains on all fours, using our hands as much as our feet, catching hold of roots as well as we could when we found them. We cleared the rocks, supporting ourselves by the least rugged of them; when the rock was too high, the few who pass by had raised against it the notched trunk of a tree, which was to serve as a ladder. The torrents are crossed on bamboo bridges, upon which one is suspended in a sort of hoop, helping one's self across with the feet or hands; or else a bamboo is thrown on the water, upon which it is necessary to balance one's self. When the streams are not too deep, they can be forded. Certain streams are used as means of communication. For two or three days one follows them, jumping from stone to stone, slipping, keeping one's self up with difficulty, and continually falling. During this journey one is never dry, as, when fortunate enough not to fall into the torrent, the rain soaks that part of the clothing which has not reached the water. Villages are few. The nearest are three days from each other. Each village contains only about a dozen scattered huts in different parts of the mountain. The inhabitants are savages, almost naked with the exception of a cloth. We were fortunate enough to find them nice people. Some spoke the dialect which our men understood; and, having had the support of the chiefs in finding some extra porters in the valley of the Salwin, whom we paid well, and who expressed their satisfaction, we were able to change them from village to village, the old ones persuading the new. Thus they gave us a good reputation, and we profited by it.

[But a great difficulty presented itself. How were forty men to be fed in such a poor country? The caravan was for the time in a precarious position.]

Starting from a small village where we had hardly been able to procure enough rice for three days, with the certainty of being unable to obtain anything for the next three days, even by making the stages as long as possible, we arrived one evening at the banks of a torrent which ran into a river whose right bank we were following. There was a rope-bridge across the stream, but the water was so high that it was impossible to cross by it; we ran the risk of being half under water, and of being drawn in by the current. The natives told us that they generally crossed it on rafts. But now nobody would attempt to do so; it was

too dangerous. When the waters rise, they told us, no one crossed; they stayed at home. What was to be done? One could not think of turning back, owing to the difficulty in obtaining food. The idea of returning did not delight us. It was impossible to think of crossing the river. To follow up the torrent further would have been very difficult, as there was no path; and since we had only three days' provisions, there was no time to lose. We decided to wait until the next morning, and 'pitched our tent on a heap of pebbles, with our men around us. At the end of an hour we observed that the waters continued to rise, and threatened to swamp us. There was only just time to decamp. It was a dark night, and the rain was pelting; we packed up our baggage and took refuge under a great rock in the wood. The Chinese cook, who hardly ever complained, was in tears. You may imagine what a night we all spent, crouched one against the other under the rock, and, without appearing uneasy, what sort of reflections we each had.

The rain continued. It was impossible to make any arrangements. At daybreak I hardly thought of going to see the condition of the torrent, being persuaded that it could only have increased. While they were philosophically lighting the fire, one of the men cried, "The water has gone down." I could not believe my eyes; it was nevertheless true. By a phenomenon which we had the opportunity of verifying again later on, the level of the water follows a regular movement according to the time of day—low in the morning, and increasing towards the evening. The rain ceased. We were saved! We crossed the rope bridge. It is impossible to imagine our delight when we found ourselves on the right bank. We had got out of a very great difficulty, of which, had the waters remained in the same condition as the night before, I should not have been able to find a solution.

During this part of the journey we had traversed from east to west a part of the basin of the Irawadi. We had crossed and followed for some days one of the two branches which form the river. The passes which we had crossed had been numerous, the highest being as much as 3600 metres (11,812 feet).

2. *The Plain of Khamti.*

For some time the natives had been telling us of a wide plain which they called "Apon," and later "Moanan." They described it as quite a paradise in which every possible want is supplied. It has numerous villages, inhabited by people with black teeth wearing turbans. Each member of our company now pressed on to reach this promised land. They were delighted with the idea of marching on level ground, and obtaining salt; for we had been quite without salt or grease for ten days, and had eaten nothing but rice boiled in water without any seasoning. Still holding to our westerly course, we reached this plain on November 18. It forms the floor of the valley of the Nam-kiu, the western branch of the Irawadi. We were surprised to find in the Khamti country (such is the name of this plain) both Thans and Thaïs speaking the language of their kindred on the banks of the Mekong, and using a character very similar to that which is met with from the Canton river and the Paï country in the centre of Yunnan, as far as the mouth of the Menam.

[Although now in a known region, already visited by English travellers, the explorers find their greatest difficulties only beginning.]

We passed our time in wrangling with the local authorities. The relatives of the king exhibited a rapacity which disgusted us. After receiving very valuable presents, they came to beg rupees of us. The son of the king went so far as to ask for my boots, and yet he prides himself on having been to Calcutta. Whilst maintaining a firm attitude, we were unfortunately obliged to submit to a part

of the demands of the Khamti people, without whose help it would have been impossible to continue our journey. Another difficulty was that of making ourselves understood. This is how we had to manage: we spoke in Latin to Joseph; he spoke in Chinese to one of our Tibetans, Siranseli, formerly a goldminer; Siranseli passed on the communication in Lissu to one of the native porters from the mountains; the porter spoke in his own tongue to a Thaï who understood it; and the last-named repeated the sentence to the Khamti chiefs. These latter seemed to consider their behaviour quite natural, for in the midst of their incessant demands, they smiled most benignly on us, and even indulged in banter.

3. *From Khamti to Assam.*

Having at last come to an agreement with these chiefs, we got ready to start for Assam. Three routes lead thither: one towards the south, not crossing any high mountains, but lengthy and already used by the English; one towards the north in the direction of the Zayul frontier, traversing the dangerous Mishmi country for some days; and a third towards the west, between the two frontiers, passing over numerous mountains, but offering the advantage of being the shortest, and of having never been followed by a European. We therefore decided on this last.

On November 24 we left Khamti for the passage of the mountain range which separates the basins of the Irawadi and the Brahmaputra. This last section of the journey was the most dangerous and the most trying. In addition to the difficulties of the route itself, which resembled those we had already experienced—torrents to be followed or crossed, five successive ridges to be traversed, rocks in the path, and bamboo bridges requiring a steady balance in the passage—we were assailed by a series of obstacles of another class. Each day something unexpected occurred to arrest, or at any rate to retard, our march. We had not been accustomed to so many mischances.

[These difficulties consisted in the discovery that the length of the route had been underestimated, which caused the supplies to run short in a wilderness of forests and mountains; in the desertion of eight porters; and in attacks of fever brought on by the night-mists of the Khamti country. The traveller proceeds:—]

After a few days my companions also were prostrated by fever. Roux was seized with a violent attack, and Briffaud was soon assailed in his turn. My feelings at this time may be imagined, and, in writing the account, I still shudder at the thought of the disaster which nearly overtook our little band.

When my comrades fell ill we had already advanced for eight days, and had almost reached the halfway point. To return was impossible in the state the men were in; a month's halt in an unhealthy neighbourhood would perhaps bring them no nearer recovery. It was impossible to send in search of provisions, and consume our present supplies on the spot, with the chance of getting no more. There was nothing for it but to advance. I therefore divided the column in two, sending the weakest on at once with the natives and the guide, with instructions to mark the route, and, in case of their reaching a village before us, to send us provisions immediately. I decided to wait a day myself, with the strongest of the party, in order to allow my comrades a rest.

The day having passed, Roux still had not the strength to set out. He begged me to start with the second column, giving me a paper certifying that it was at his own urgent request that I proceeded. I left him with two men and twelve days' rations. Whatever it cost me to leave a sick companion thus amongst the mountains, perhaps at eight days' distance from the possibility of replenishing his supplies, I felt that it was my duty to proceed. By staying I should only add one

more to the mouths to be filled, and I might be more useful in hastening forward with all speed and arranging a succour. Briffaud, in spite of his weakness, accompanied me.

Two days later we crossed, by a pass 10,000 feet high, with a little snow on it, the range which separated us from India. The joy of having reached the goal of our journey was damped for me by the anxieties which constantly harassed me. At the foot of the pass we found two men of the advance column, who had stayed to search for an old man, who, in his feeble state, had lost himself during the night. Alas! he had not been found. Tigers abounded, and his fate was sealed. During the night, on a terrace in the midst of the rhododendrons amongst which we were encamped, my men united in a circle, and, turning towards Tseku, fell on their knees and recited long litanies for nearly an hour. The tops of the trees were swayed by squalls from the west, whilst a few half-burnt logs threw a glimmering light on the mournful scene. I have never in my life seen a spectacle so striking or so profoundly sad.

During the succeeding days it was a forced march by long stages. Every one exerted himself to the utmost, knowing well that an advance must be made at all costs. It was a case of fleeing from death. Our provisions were getting low, and yet we were on strict rations. The men took only two meals in the day—three porringers of rice much swelled with water. We were only half a day behind the first column, which we knew to be a little better supplied than ourselves. We therefore sent on two native porters who had remained with us, to endeavour to overtake it. They were to tell those in front to leave us a little rice.

We hold on: we have only one meal more; and then, none at all. We are forced to leave behind two of our sick men, who cannot travel so fast as the rest of us. We will send them rice the moment we have it ourselves. The tent and all our baggage, save the blankets and one or two cooking-utensils, are abandoned. Our march is retarded by continual streams and torrents, through which we have to wade with the water up to the armpits. The men have been marching twenty-four hours without a morsel to eat, when we find a man left by the advance party with a sack of rice. We are saved!

We learnt, moreover, that we were only one day distant from a small village. It was imperative to think at once of the two sick men left behind. I promised a large reward to any one who would carry them succour. An old Tibetan, Jayo, came forward, and started back to bring on his comrades, after supplying them with food. At the first village, inhabited by subject Mishmis, we found the advance party, which, though it started twenty-four hours before us, had only been three hours in advance at the finish. We at once collected all the rice we could, and sent it back with two natives and one of our own people. They would be able to retrace their steps for at least six days, and provision Roux's small column. Provided he had been able to cross the pass, he was safe.

We had succeeded so well in supplying the needs of our comrades in distress in the rear, that we found ourselves with scarcely anything left for our own wants. The people would not sell us any more. With rather less than a day's supply, we set out for the first important village of Assam, Bishi, which we were assured was two days' march distant. We had sent on two natives in advance to this place, to send us back some rice, so that we started without a great deal of anxiety. But, unfortunately, our guide lost his way. He led us astray into the bed of a small torrent, saying that it flowed into the Diyung, and as the latter passed by Bishi, we were sure to find the village. We passed another sad evening, and our poor men seemed this time thoroughly discouraged, and with good reason. The following day after having laboriously cut ourselves a path through woods, we arrived about midday

at a fisherman's hut. We bought some rice and fish, and they showed us the way. A few hours later we met some of the Bishi people, come to meet us with a supply of rice. Henceforth our troubles ceased.

[Bishi is reached on December 16, and its inhabitants prove friendly and very different from those of Khamti. The two sick men and the brave Jayo rejoin the column, but anxiety is still felt about Lieut. Roux. The limited supplies at Bishi make it, however, necessary to advance.]

Early on the 20th I sent on the men to Khagan, remaining at Bishi, with Briffaud and two or three other men, with the intention of starting at midday. It was well that I did wait thus, for as I was writing, at about ten o'clock, Roux's arrival was suddenly announced by the cry of "Lu Tajen" from my men. It was, in fact, my companion with his two porters and those who had been sent back to him with provisions, all safe and sound. His porters had had fever on the way, and subsequently a sudden rise of the Diyung had delayed the little band two whole days. But they arrived at last, and we were all reunited in safety, which was the main point. I reckon December 20, 1895, as one of the happiest days of my life.

We have succeeded, and if our efforts have turned out well, we ought to ascribe a share in the success to the missionaries of Tibet, without whose aid we should never have been able to find followers, and a share to these followers themselves. We found ourselves at the head of a wonderful band of men, physically sound, active, and enduring, and in their moral character, zealous, disinterested, and devoted. Our men, whom we feel a pleasure in taking down to Calcutta with us in order to send them back by Rangoon and Bhamo, are not mere porters in our eyes. They are rather children with whom we live in community of feelings, as with the members of one family. Brave and generous souls! I cannot sufficiently admire them, and they owe much of their good qualities to the wholesome and kindly influence of the French missionaries.

[From Bishi the explorers start together for Sadiya, finding on the way provisions and boats sent by Mr. Needham, the explorer of the Lohit-Brahmaputra in 1884.]

In short, in the midst of our miseries, after the material difficulties which surrounded our journey as far as Khamti, we have had, in the words of the English whom we found near the frontier, a great piece of luck—that of slipping through between the Mishmis to the north and the Singphos to the south. These two peoples, who are constantly at war with the English, if they had done no worse, would certainly not have allowed us to pass.

The first result of our journey from Tseku is the indulgence of a slight feeling of pride. We, Frenchmen, have been the first to traverse the shortest and most direct route from China to India, a route which so many Englishmen have searched for in vain on both frontiers. I hasten to add that it is not practicable for trade.

As to the geographical results, we are also the first to disprove the theory of General Walker by certain evidence. In the map published under his superintendence, in 1894, by the Royal Geographical Society, the Salwin is shown as having its source in the latitude of Chamutong (that is to say, of Tseku), whilst the large stream which rises to the east of Tengri-nor, and traverses part of the inhabited portion of Tibet under the name Urchu, is considered to be the Upper Irawadi. But the Urchu, as we will show, is nothing but the Upper Salwin, which we found as far north as the latitude of Ta-li-fu, and afterwards crossed at that of Chamutong. Between these two points we were able to lay down the course of the Salwin, and the villages which line its banks, by inquiries made each day whilst we were ascending the right bank of the Mekong.

We crossed the upper branches of the Irawadi, and, by means of the information

received and the views we obtained from the various passes which we traversed (we could see very distinctly from some of them the high chain which bounds the south of Zayul, a few days' journey off), we were able to fix, within a few miles, the points whence these branches take their origin. The three main branches which make the Irawadi are, starting from the west, the Kiu-Kiang, the Telo, and the Nam-Kiu. The two former have the greatest volume of water. They are not marked on the maps. The most northern branch, the Kiu-Kiang, comes from no higher latitude than 28° 30′ N.

From Atentse onwards, my companion Roux surveyed the route most carefully with the compass, and was able to take numerous bearings of remarkable peaks. Even when sick and alone among the mountains, he never intermitted his work until he reached a known point. Thanks to the means of verification supplied by the bearings, I do not think the results obtained can be vitiated by any important error. As to our collections, we were scarcely able to make any relating to natural history after Tseku, marching as we did on foot, and being unable to carry much. I left payment at Tseku for some skins of animals which the people promised to send me, and which I think should be interesting.

We were able to do more under the head of ethnography. I have obtained several vocabularies, and copious notes on the hitherto little-known tribes.

During eleven months' journey from Tongking we have worked as far as possible for the honour and profit of our country, and if those at home who take an interest in scientific and commercial questions are satisfied with the results obtained, all our hardships will soon be forgotten, and we shall consider ourselves amply recompensed for our trouble.

BOUNDARIES OF BRITISH GUIANA.

By CLEMENTS R. MARKHAM, C.B., F.R.S.

(*Postscript to Article on page* 277.)

It is important to explain the mistake about the first and second Schomburgk Lines. In reality there is one Schomburgk Line only. In 1840 Schomburgk published a small volume entitled 'Description of British Guiana,' illustrated by a map drawn by Mr. Arrowsmith. The map itself was drawn on Schomburgk's authority before returning to Guiana. But there is a red line across it to represent "the boundary as claimed by Great Britain," for which Mr. Arrowsmith is solely responsible. It is officially repudiated, and is of no authority. Schomburgk had nothing to do with it. The proof of this is that the same line appears on Arrowsmith's map, in his Atlas of 1832. It is erroneously called the first Schomburgk Line, and has often been copied.

The true Schomburgk Line is shown on the official map. The portion from the mouth of the Amakura to the junction of the Akarabisi with the Cuyuni was discovered and surveyed by Schomburgk himself in 1841. The portion about Mount Roraima, as far as Mount Irutibuh, was also surveyed by Schomburgk. The rest, following the Cuyuni river, is drawn in accordance with the proposal in his report. When Sir Robert Schomburgk completed his surveys he sent in six reports, and compiled two maps which have never been published. His own maps, on a very large scale, only carried the line to the junction of the Akarabisi with the Cuyuni. All this material was placed in the hands of Mr. Hebert, of the Quarter-Master General's Department at the Horse Guards, who compiled a beautiful map, showing the complete Schomburgk Line, in 1842. This map was lithographed in 1887. It was compiled exclusively from Schomburgk's materials. Copies of this official map, in two sheets, have now been presented to the Royal Geographical Society.

THE MONTHLY RECORD

EUROPE.

The Jubilee of the Russian Geographical Society.—On January 21 (February 2) last, the Russian Geographical Society celebrated its jubilee. Numerous telegrams and letters of congratulation were received from all parts of the civilized world, from other geographical societies and scientific bodies, as well as from different parts of Russia itself, where the society has several branches. The Emperor addressed to it a letter couched in very sympathetic terms, in which the study, by members of the society, of the customs and institutions of the motley populations of the Empire, as preparatory to a better understanding by the Government of the conditions for their peaceful development, received special acknowledgment. The Emperor announced a further yearly grant of 15,000 roubles (£1500), in addition to the 15,000 roubles already received by the society from the State's exchequer. A full history of the scientific activity of the society was prepared for the day by M. P. de Semenoff, who has been for so many years president of the Physical Geography Section and vice-president of the society, and long abstracts from it have been published in the *Historical Review* (*Istoricheskiy Vyestnik*), while M. de Semenoff's jubilee speech contains a brief summary of the same. The whole work, 1500 pages thick, containing many portraits, was issued same day. The idea of the foundation of a geographical society originated in St. Petersburg in the year 1844, in four different circles: the circle of the navigators, Lütke, Krusenstern, Wrangel, and Ricord; the Academical circle of the naturalists, Karl von Baer, Struve, Helmersen, and the statistician Köppen; the circle of the General Staff officers, Th. Berg (later field-marshal) and M. N. Muravieff; and the circle of men, mostly young, anxious to promote Russian science—the geographer, Arsenieff; the well-known traveller, Chihacheff; the great student of the Russian language, Dahl; Perovsky, who became known later on by his journeys to Central Asia; and Prince Odoevsky; round whom gathered the brothers Milutin, P. Valueff, S. Noroff, Vernadskiy, Count Uvaroff, Kavelin, Samarin, P. P. Semenoff, and others. This was quite a phalanx of future scientists and statesmen. Of these individuals, whose names are now familiar in science, the naval officers Lütke and Arsenieff were tutors of the young Prince Constantine, and it was through them that permission was obtained from Nicholas I. to found the society. The quadruple origin of the society is extremely interesting, because it led soon to the division of the new society into four sections (mathematical geography, physical geography, ethnography, and statistics), each of which had its own meetings, its own secretary, and its own life; in this way much more scientific work could be done than if all four divisions had been huddled together. This is one of the reasons why such a variety of scientific researches in the four domains into which geography was subdivided has been done by the Russian Geographical Society, and also why its expeditions have always taken the character of scientific explorations, as is strikingly shown in the explorations of Karl Baer, Hoffmann, and Helmersen in Russia; Ludwig Schwartz and his followers in Siberia; Semenoff, Severtsoff, and Prjevalsky and their followers in Central Asia. At the same time, as the learned ex-president points out in his jubilee speech, the desire of getting rid of serfdom, which inspired the generation of 1844, and consequently the desire to know better the life of the Russian people, also found its expression in the society, rallying round it some of the best forces of the country, which took a leading part in Russian economical science, history, and public life. The same tendency led many members of the society to devote their energies to, and to take the initiative in, the study of the customary law, the organization

of landed property, and the judicial customs prevailing both in Russia proper and among the mountaineers of Caucasia, the Mussulman population of Turkistan, and the natives of Siberia, thus preventing a reckless destruction of their institutions by the State. This is what the Imperial letter makes allusion to. In his brief review of the society's activity, M. de Semenoff divides its history into four distinct periods. During the first period (1845–1850), under the vice-presidency of Th. P. Lütke (the Grand Duke Constantine being the honorary president), the society sent out the well-known Ural expedition, under K. Hoffmann, which may be said to have laid the foundations of Russian geology. During the second period, which is described as the "nationalist period" of the society, the foundation was laid, under the vice-presidency of M. N. Muravieff, of the study of the Russian people itself—its ethnography and institutions—and only the first steps were taken for sending out the great Siberian expedition. The two branches, Siberian and Caucasian, were founded at that time, and this idea of having quite independent but affiliated societies in the different parts of the Empire proved to be most productive of local research. The third period (1857–1871), during which Count Lütke was again vice-president, is distinguished by great geographical activity. The great Siberian expedition explored Siberia, the Amur, and the Usuri territory; numerous expeditions went to the Tian-Shan and the recently annexed Turkistan; to Manchuria, Mongolia, Kulja, Kashgaria, and even to Persian Khorassan. The basins of the Caspian and the Aral Seas were opened for scientific exploration; while within Russia itself the grain trade, the village community, and the ethnography of West Russia were busily studied. To the fourth period (1871–1896), M. de Semenoff gives the name of the period of the expeditions of Prjevalsky. An immense part of Central Asia was conquered for science during that period, while members of the society explored Mongolia, the unknown parts of China, Northern Siberia, the outskirts of Turkistan, and the Aral-Caspian depression, and began a series of detailed and exact works, such as the levelling of Siberia and the Aral depression, the meteorology of Central Asia, the polar station at the mouth of the Lena. At the same time a series of exact geodetical and hydrographical surveys, often discussed and prepared in the society, were accomplished by specialists, who are all members of the society, and communicate to it the results of their special work. At the present time the society becomes more and more a centre of union for all those who devote themselves to the scientific and detailed natural history exploration of the immense territory of Russia.

ASIA.

The Trans-Siberian Railway.—It appears, from the last official reports published in the *Official Messenger*, that the state of the Trans-Siberian railway on December 11, 1895, was as follows: The first section, Chelyabinsk to Omsk, 493 miles, was quite ready; the temporary stations were erected along the whole line, and the iron bridge across the Irtysh was building. The cost of a second-class return ticket from St. Petersburg to Omsk (2673 miles) is, according to the new zone tariff, less than eight pounds. On the second section, from Omsk to the Ob river, near Tomsk, 384 miles, rails were laid on the whole length, and all wooden bridges were ready; more than two-thirds of the necessary earthworks were finished, and the great iron bridge across the Ob (2520 feet long) was begun. On the third section, Ob to Krasnoyarsk, 476 miles, the rails were also laid on the whole length on December 17, 1895. All wooden and smaller stone bridges were finished, and over one-half of all earthworks were completed. It may thus be said that very soon St. Petersburg will be connected by rail with the Yenisei, on a length of 3057 miles. On the next section, Krasnoyarsk to Irkutsk, 672 miles, where the first difficulties

are met with, as the railway has to cross a hilly region of moderate height, nearly 38 per cent. of all earthworks were accomplished, and part of the smaller bridges were built. On the Trans-Baikalian section, 701 miles long, from Mysovaya, on Lake Baikal, to Sryetensk on the Shilka (the head of the Amur navigation), where the railway has to be pierced in the steep rocky foothills along the southern shore of the Baikal, and then, gradually rising on the plateau to the height of over 3500 feet, has to descend to Chita, the work was also begun, and part of the rails was shipped to Vladivostok. As to the Pacific end of the railway, the line from Vladivostok to Grafskaya on the Usuri, 250 miles, was completed, and nearly quite ready; while on the North Usuri section, Grafskaya to Khabarovsk, 225 miles, where very great difficulties are to be surmounted on account of the low and marshy character of the region, partly inundated during the heavy rains of the latter part of the summer—73 per cent. of the work of clearing the forests, and 52 per cent. of the earthworks had been completed. As is known, it also enters into the plan of the Siberian railway to connect the northern line, Perm to Tyumen, with the southern main trunk, by means of a branch railway between Ekaterinburg and Chelyabinsk, 150 miles long. This important line, which will bring the main trunk in connection with all the chief ironworks of the Central Urals, has progressed very satisfactorily, rails having already been laid over the whole of its length. Finally, a new great line, which will cost about 35,000,000 roubles, has been projected. It will connect Perm (on the Kama) with Vyatka, and this last with Kotlas, a river-port at the junction of the Vychegda and the northern Dvina, attaining a total length of 619 miles. This great north-eastern railway is intended to direct the cereals, which will soon be exported in large quantities from Western Siberia, towards the port of Arkhangel, and it will certainly give new life to Western Siberia, by opening for it a port on the White Sea. The preliminary exploration on this line is completed, and building begins this year.

Distribution of Armenians in Asiatic Turkey and Transcaucasia.—The first number of *Petermann's Mitteilungen*, 1896, has an article on this subject, illustrated by a map compiled by the editor, embracing the eastern parts of Asia Minor, Turkish Kurdistan, and Armenia, Northern Syria, and the south-west of Transcaucasia. The text is based, with reference to the Turkish area, on a communication by Lieut.-General Selenoy to the eighteenth volume of the *Zapiski* of the Transcaucasian section of the Imperial Russian Geographical Society, and with reference to the Russian area, on a statement drawn up by the Russian Councillor of State, N. v. Seidlitz, on the basis of the family registers of 1886. The main authority followed by Selenoy is Vital Cuinet's "La Turquie d'Asie," the figures in which have been collated with those of all other available authorities, and corrections made in accordance with explanations given in the text of the article referred to. Lieut.-General Selenoy's paper deals specially with the nine vilayets of Erzerum, Bitlis, Van, Diarbekir, Mamuret-el-Aziz, Sivas, Trebizond, Aleppo, and Adana, and the main general results are the following: (1) that in these nine vilayets collectively the Armenians do not make up a sixth of the entire population, the number of the Mohammedans is five times that of the Armenians, while Greeks, Nestorians, and other Christians make up about one-tenth of the population; (2) that in the five vilayets of Erzerum, Van, Bitlis, Mamuret-el-Aziz, and Diarbekir, which contain two-thirds of the Armenian population belonging to the nine vilayets named above, the Armenians form scarcely a fourth of the entire population, the Mohammedans being nearly three times as numerous, and Greeks, etc., constituting about 7 per cent. of the population; and (3) that Armenians form the larger part of the population in none of the nine vilayets, in only one (Van) out of the 25 sanjaks into which the first eight vilayets are divided (details are wanting

for the vilayet of Adana), and in only nine out of the 159 kazas into which these 25 sanjaks are subdivided, and that only according to the estimates most favourable to the Armenians. In Transcaucasia the Armenians exceed 50 per cent. of the population only in the government of Erivan. In that of Elisabethpol the proportion is 35 per cent.; in that of Tiflis, 24 per cent.; in the territory of Kars, 21 per cent. In no other government or territory does it amount to as much as 10 per cent.

AFRICA.

The Source of the Niger.—Colonel J. K. Trotter, of the Intelligence Branch, member of Council R.G.S., who is taking part in a joint delimitation between Sierra Leone and French territories, writes as follows from Tembi Kundu, under date January 10: "We got here, both Commissioners together, yesterday, and found the Niger source very distinctly marked. It is a small spring issuing from a hillside in a deep wooded ravine. On the rock where the stream issues is inscribed 'G. B. 1895.' These are the initials of the French captain, Brouet, and the bottle he placed in the stream is still there. The natives are afraid to look on the water, believing that if they do they will die within a year, and our guide who took us to the place couldn't be persuaded to enter the ravine. They were anxious that we should offer a sacrifice to the devil, the only deity they acknowledge. The position of Tembi Kundu is in lat. 9° 5′ 20″ N. (mean of observation). As regards longitude, we must wait till we get Grant's results next month. Tyler, who is with me, is going to take a photograph of lunar distances (Hill's method) when the moon is available, which is not for about fourteen days. We have travelled too fast to carry meridian distances, but had a two days' rating at Kon, which, after rating here, may give us some approximate results. Our longitude by traverse (perambulator), checked by latitude, and allowing for circuitous routes, makes this place about 10° 50′ W.—much further west than we expected. We have taken latitude at almost every halting-place. The height by aneroid of our camp is 2800 feet (mean of reading). This is a surprise to us, as we believed we were going up to 6000 feet, from what previous reports told us. The aneroid was compared at sea-level, and is, I think, trustworthy, as there is very little change in the barometer from climatic causes in this country. There are mountains in sight which must be over 4000 feet high. Within 250 yards of the Niger source is the source of a river flowing south-east into Liberia, and about half a mile to east is the source of the Bagwe river, flowing into Sierra Leone. The watershed is very clearly marked in this neighbourhood, and the country is fairly open, the valleys only being wooded, and the hills covered with dry cane brake, which the natives have burned in many parts. It is a great comfort, after travelling for a month in the bush, where one doesn't get a view above once a fortnight, to get one's head above water and see the whole country round. Tyler has taken and developed many photographs. The French captain, Passaga, has also taken a large number."

The New State of Belda, in the Central Sudan.—M. Antonin Goguyer draws attention in the *Revue Française et Exploration* (August, 1895) to the importance of the lately founded state of Belda, in the region between Lake Chad and the Benue, and its probable influence in moulding the future history of those regions. The writer traces the events which led to the foundation of this state by Hayato, a zealous propagandist of the Tijani sect of the Mussulmans of those regions. According to the account given, this man was a prince of the ruling family at Sokoto, who, partly through the reputation for piety of his father, partly through alliance by marriage with the Tijanian *Moccadem* of Ngaundere, has acquired an immense influence among the Fulbe, especially among the chiefs of Mandara, Marua, and other places near his residence at Belda. The adventurer,

Rabah, paid a tribute to his importance by forming an alliance with him before setting out for the conquest of Bornu. M. Goguyer thinks that this state is destined to overthrow the tottering empire of Sokoto, and draws conclusions as to the policy which France should pursue in view of the coming revolution. This subject cannot be touched upon here, though it may be remarked that M. Goguyer's statement that Belda falls within the French zone is difficult to understand. Dr. Passarge, in his book on 'Adamawa,' lately published, gives some particulars as to the rise to power of Hayato, but throws doubt on the statement that he was a prince of Sokoto. As the last-named writer remarks, Belda was in Barth's time a pagan village placed on a rocky height.

Dr. Stuhlmann on the Uluguru District, East Africa.—Dr. Stuhlmann contributes to the *Mitteilungen a. d. Deutschen Schutzgebieten* (1895, No. 3) a sketch of the Ulunguru mountains, from observations made during his visit in the latter part of 1894. The district lies a little away from the edge of the central plateau, abreast of Southern Usagara, from which it is separated by the plain of the Mkata. The central mass consists of gneiss, forming in the north a chain of rugged peaks, and in the south the extensive plateau of Lukwangulo. It is surrounded on the east, west, and south by outlying hills, separated from it by longitudinal valleys. Numerous streams have cut deeply into the mountain mass, forming transverse valleys in the central parts, but afterwards longitudinal ones in the direction of the strike of the rocks, and finally breaking through the outer edge by a transverse valley. All find their way into the Kingani, which derives practically all its water from this region. The central and higher parts are exceedingly moist, cloud and mist being prevalent, and rain falling nearly every day. At an altitude of 6000 feet the thermometer often remains for days together no higher than 68° Fahr., while in the valleys of the outlying hills a shade temperature of 93° to 95° occurs. The steppe vegetation of the outer fringe of the district, which betokens great dryness, gives place in the intermediate valleys to tropical forest, lianas, and ferns. On the slopes of the central mass, the primæval forest, which covers its upper parts and sends down arms into the valleys, has apparently been cleared by the agency of man, its lower limit being clearly defined. The upper forest consists of giant trees interspersed with tree ferns, tree lobelias, etc., and draped in the higher parts with lichens, which give it a weird appearance. On the Lukwangulo plateau the forest gives place at 7500 to 7800 feet to a grassy upland, sprinkled over with stunted trees. Dr. Stuhlmann makes some interesting remarks on the decrease of the forests, and the probable change of climate which prevents its renewal when once destroyed. He agrees with Prof. Engler (*Journal*, vol. v. p. 170) in supposing a former connection with the West African forest region. The district is inhabited by various tribes under petty chiefs, and is thickly peopled. Maize is the chief crop, being grown in clearings on the slopes and reaped four times a year. Few cattle are reared.

Ports of Senegal.—The *Bulletin* of the Paris Society of Commercial Geography (1895, p. 774) contains some notes by a correspondent at Dakar, on the condition and prospects of the various commercial outlets of the French possessions on the Senegal. Dakar, in spite of its recent growth, and the advantages offered by its spacious bay, has not yet become the important port it might be, although the decision to make it a military port was arrived at long ago. It suffers much from want of quay-room. Its trade is subject to the rivalry of Rufisque, on the other side of the bay, the head-quarters of the export of ground-nuts (though the shore there is little protected); of Saint-Louis, which must always be the outlet for the trade of the Senegal river, in spite of the obstacle caused by the shifting bar of the river—this trade, however, is not likely ever to assume very great proportions;

and of Gorée, which by its free port attracted a considerable amount of commerce, the German and English lines of steamers making it a point of call, but which is now rapidly declining in importance. Dakar has, the writer says, allowed itself to be distanced by the port of La Luz, in Gran Canaria, of the growing importance of which he spoke in a previous letter. He expresses a doubt whether the commerce of Senegal is ever likely to be large enough to supply a multiplicity of outlets, and appears to favour a policy which would make of Dakar the administrative, no less than the commercial, capital of the country.

AMERICA.

Explorations in Canada.—The 'Report of the Commissioner of Crown Lands for the Province of Quebec,' for the twelve months ending June 30, 1895, contains the account of an important journey made by Henry O'Sullivan, D.L.S., inspector of surveys for the province, in the autumn of 1894, in the lands belonging to the Hudson Bay slope north of the upper Ottawa, and in the adjacent parts of the Ottawa basin. Till 1893 an area of about 50,000 square miles (as large as England) in this region remained unexplored, and was generally considered to be a cold rocky waste, in which there was little use in searching for anything worth having, except perhaps fish, game, and minerals. Mr. O'Sullivan's journey puts a totally different complexion on, at least, a considerable portion of this region. From what he has seen, he has very little doubt that there exists, "beyond the sources of the Ottawa, a fertile region several thousand square miles in extent, where there is an abundance of merchantable timber, principally tamarac, of which there is a sufficient quantity to supply sleepers for all the railways in the Dominion." The area embraced by Mr. O'Sullivan's route, which is illustrated by a map on the scale of about 1:380,000, is about 7000 square miles between Grand Lake Victoria and the upper Ottawa river in the south, and the north end of lake Waswanipi in the north. He started from the northern end of Grand Lake Victoria, the point fixed by him in a previous survey, in 1893, as in 47° 48′ 25″ N., 77° 20′ 05″ W., at an altitude of 960 feet, and proceeded thence northwards. About 3 miles from this point, instead of about 30 miles as was expected, the height of land was reached at an altitude of about 1000 feet. A portage only 6 chains in length here separates the waters of the Ottawa basin from those of the Mekiskan basin on the Hudson Bay slope. Immediately after crossing the water-parting, a remarkable difference was perceived both in soil and timber. In the upper Ottawa valley the prevailing rocks visible on the surface are gneiss and granite, and the soil is generally sandy and frequently strewn with boulders. The prevailing timber is Banksian pine or cyprès, which dots the surface here and there. North of the water-parting, on the other hand, the geological formation is nearly all sedimentary rock, the soil is rich clay without boulders, the surface is level or gently undulating land, and the trees are poplar, "bouleau," and tamarac; no more cyprès; and though poor, rough, broken country, with cyprès and black spruce, was passed through in some of the higher tracts traversed on this journey, fertile clay lands continued to be the rule at lower elevations. From the height of land, Mr. O'Sullivan's route was first northwards through a series of lakes connected by stretches of river with rapids, the last of the lakes, Lake Shabokoma, receiving from the east, near its south end, in 48° 26′ 35″ N., 77° 10′ 20″ W., the river Mekiskan, which from this point flows northwards, and ultimately north-westwards. The lake just mentioned, previously unknown, lies at the height of 850 feet, and has a length probably exceeding 40 miles, with a varying width. Its southern portion, 22 miles long, is mainly part of the course of the Mekiskan, and, from native reports, Mr. O'Sullivan concludes that it extends about 20 miles north-east from

the point where the Mekiskan issues from it. After joining this river, Mr. O'Sullivan followed it as long as it maintained its northern course; but at the point where it begins to flow north-west, about 49° 12′ N., he diverged eastwards up a small stream which he called the Wedding river, on account of his having discovered it on the anniversary of his wedding-day. From this river he crossed the water-parting to the Otter creek, which led him to Lake Waswanipi, a magnificent sheet of water at the height of 680 feet, "surrounded by a splendid-looking country, level or gently rising in easy slopes, of the richest soil all around, timbered with large spruce, fir, tamarac, bouleau, poplar, etc." The Hudson Bay Company's station at the north end of this lake was the terminus of the outgoing journey. The return was made southwards by the Little Waswanipi, part of the upper Mekiskan, and the Kekek Sibi, to the height of land separating the Mekiskan and Ottawa basins in 48° 8′ 45″ N., 75° 53′ 45″ W., and thence south-westwards by the Kapitajewan, and finally south to a point on Wagner's Line on the Ottawa in 47° 56′ 30″ N., 76° 54′ 30″ W., which formed a closing-point in his journey of 1893. Mr. O'Sullivan thinks there is every reason to believe that the climate of the fertile and well-timbered region explored by him can compare favourably with that of the country along the St. Lawrence between Quebec and Montreal; and, with regard to access, states that "there is certainly no obstacle to the building of a railway from any part of the province into the heart of this country, and canals can also be easily made between the St. Lawrence and Hudson Bay waters."

The Great Bank of Newfoundland.—Captain W. T. Main, of the Allen Line steamer *Corean*, sends us an account of his observations on the Great Bank of Newfoundland, extending over the many years during which he has been in command of steamers on the Canadian service. The Great Bank extends from lat. 43° to 49° N., and from long. 47° 30′ to 57° 30′ W., with depths varying from 3 to 100 fathoms, and a bottom composed principally of sand and shells. The configuration of this bank is of the utmost importance in navigation, as the soundings on it are the first obtained by a vessel crossing the Atlantic bound for Canadian ports, and the lead has to be relied upon more than in most cases on account of the prevalence of fogs. As Professor Thoulet has pointed out, the melting of the drifting icebergs from the Arctic regions has probably led to the formation of the bank, and Captain Main shows how the charts of the survey of 1859 are rendered quite untrustworthy by the accumulation of ice-borne *débris* in some places, and the ploughing action of large icebergs which materially increases the depth in others. The soundings on the northern part of the bank are also not numerous enough for practical purposes. Captain Main supplemented these soundings, and on his report of a bank the depths on which were characteristic enough to be of service in approaching the port of St. John's, one of H.M. ships on the North American station surveyed it in 1893, and confirmed his opinion of the value of these soundings in navigation. The bank is 8 miles long from north to south, and 5 miles broad from east to west, with depths of from 59 to 77 fathoms; the middle of the western edge of the bank lies 21 miles due east of Fort Amherst, at the entrance to St. John's harbour. The soundings to eastward and also westward of the bank close up to the shore range from 80 to 90 fathoms. By steering a course so as to cross this bank from the westward, a comparatively ice-free track is obtained, as most of the bergs carried by the Arctic current sweep round the north-east of the Great Bank, or strand upon its northern edge.

The Nicaragua Canal.*—The waterway is to start from Greytown, where it is proposed to create a harbour, if this is not impossible as some suppose. Proceeding

* 'The Key to the Pacific.' By Archibald R. Colquhoun. London: A. Constable & Co., 1895.

towards Lake Nicaragua and the Divide, ships are to be lifted through three locks, with a rise of 45, 30, and 31 feet respectively. They will then pass through the Divide, an excavation under 3 miles long, and for which 12,000,000 cubic yards must be removed, of which 7,000,000 consist of solid lavas, etc. They will next navigate a series of vast basins and the San Juan river to Lake Nicaragua. In order to produce these navigable waters, a series of gigantic dams is to be made. That at Ochoa over the San Juan valley is to be 1250 feet long and 70 feet high, and there are many others from 70 to 20 feet in height. These dams are to be made by stretching cable trams across the valley, and patiently tumbling down rocks until these find a permanent home in its bed and gradually form the embankment. Lake Nicaragua, with some 1200 feet of dredging, affords a waterway of 56½ miles, after which the ships are to be conducted down the Rio Grande valley to Brito. This valley will be turned into another reservoir by a huge embankment 1800 feet long and 70 feet high, and three more locks are provided to lower the ships 110 feet, whence they will proceed to the proposed harbour at Brito, and emerge on the Pacific. This truly gigantic undertaking, the cost of which is estimated at £30,000,000, will, according to Mr. Archibald Colquhoun, "certainly be made." Three points are, however, considered by some authorities to be impossible, viz. the Ochoa dam, the Divide excavation, and the Greytown harbour. His book contains full details of the scheme, and an account of Nicaragua, which we may briefly describe as a sort of large West Indian island, with an annual rainfall of 290 inches, and corresponding climate. By no means the least valuable portion of 'The Key of the Pacific' is Mr. Colquhoun's description of the probable effect of the canal on the world's commerce. Melbourne and Yokohama will then be 9287 and 8650 miles from New York, whilst at present they are 11,350 and 11,765 miles from Liverpool. This scheme will therefore "bring about the most serious rivalry to the commercial supremacy of Great Britain which she has yet to encounter." Moreover, it is to be an "American canal in American waters," though, in some not clearly defined manner, "neutral." There is a historical summary, from which it seems clear that, if the English traders of 1698 had refrained from destroying Paterson's Scottish colony at Darien, we should now hold this "Key of the Pacific." The book is abundantly provided with illustrations, some of which are not particularly clear, and the engineering and other details are very fully described.

POLAR REGIONS.

Dr. Nansen's North Polar Expedition.—There has been widespread interest and excitement over a telegram received in the early part of February, as follows: "Irkutsk, January 31 (February 12).—The contractor for Nansen, Kushnareff, through the Kolymsk *ispravnik* (chief of police) Kandakoff, by mail from Yakutsk to Kirensk, and thence by telegraph, informs the *Eastern Review* that Nansen has reached the Pole, has discovered land, and returns."—(*Official Messenger*, February 2 (14); telegram of the Russian Telegraphic Agency.) At first the tendency was to place some credit in this telegram. But, as time passed and no word was received direct from Nansen, and as the conditions under which the telegram seems to have been sent were examined, much greater scepticism was displayed as to the truth of the news conveyed. In a letter to the President from M. Grigoriev, Secretary of the Russian Geographical Society, he expresses grave doubt as to the truth of the statement. In this he was confirmed by a conversation he had with the Governor-General of Eastern Siberia, who could not believe it possible that any official could have received such information without communicating it to him. This disbelief is shared by General Osten Sacken, as also by Baron Oscar Dickson. The latter wrote to the *Times*, expressing his belief that if the *Fram*

had been seen it must have been because she never had got to the Pole, but had been drifting about for two winters, and had approached the New Siberian islands. It is not stated that either Nansen or any of his men have been seen. On the whole the weight of evidence seems to be against the accuracy of the news. Every one would rejoice if Dr. Nansen's object had been accomplished; if it has, we ought to receive authentic information within a very short time. Meantime we can only wait.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

Deep Soundings in the Pacific.—Commander A. F. Balfour, in the course of soundings in the southern Pacific, carried on in H.M.S. *Penguin*, has come across deeper water than has before been found in any part of the oceans. Leaving Tongatabu, he went to the spot where he had in July last failed to reach bottom with 4900 fathoms of wire. Here he found 4940 fathoms, but failing to recover a specimen of the bottom, he tried again, after putting new wire on the machine, and got bottom at 5022 fathoms, a short distance from the first cast. This was in lat. 23° 39′ S.; long. 175° 04′ W. Captain Balfour steered east further into the Pacific for 50 miles, but found bottom at 3100 fathoms. Steering south, parallel to the line formed by the Tonga and Kermadec Islands and the banks between them, after getting various depths between 2200 fathoms and 4400 fathoms, he, at about 100 miles E.N.E. of Sunday Island of the Kermadec group, struck another deep hollow of 5147 fathoms, and successfully recovered a specimen of the bottom. The next sounding was 3380 fathoms, but when 100 miles east of Macarthy Island, 5155 fathoms was obtained, and a specimen again brought up. The soundings now became gradually less deep. The deepest sounding heretofore obtained was 4655 fathoms, by the U.S.S. *Tuscarora*, near Japan in 1874. The *Penguin's* deepest cast is therefore exactly 500 fathoms, or half a sea-mile deeper. Doubtless there are deeper places yet to be found. The positions of these hollows form no exceptions to the already observed fact that the deepest spots in the oceans are not far from land or shallow water, and seem therefore to be complements of the movements which have forced the submarine ranges upwards.

Morphology of Coasts.—Herr Paul Güttner discusses the geographical homologies of coasts in the *Mitteilungen* of the Leipzig Geographical Society. He defines the word "coast," not as the boundary *line*, but the boundary *zone* between land and sea, and views it as the scene of constant warfare amongst the terrestrial, marine, atmospheric, and biological agents of change. Geographical homologies are defined as "similar forms of the Earth's surface produced by the similar action of similar agencies." The various kinds of coast are minutely classified under the great divisions of coasts wrought by the action of water on hard rocks, soft rocks, and on detrital material, and by the action of living creatures. The second half of the essay deals with the special conditions of low coasts, such as are produced by the action of rivers distributing detritus. The sinuosities of these coasts are compared with circular arcs, and, as an index of curvature, the author takes the cosine of half the angle subtended by the arc inscribed in the bay. A table of 436 incurves or outcurves of low coasts is given, showing the name or some particulars by which the place can be found on a map; the latitude and longitude to seconds of the beginning and end of the curve; the actual measured radius in millimetres of the corresponding circle; the angle subtended by the arc; the radius in kilometres; the index of curvature; and an indication as to whether the curve is convex or concave to the sea. The mud coasts under consideration are found mainly in regions of great rainfall, and their curves vary in every gradation from straight lines to closed circles—in lagoons or islets—chains of which, parallel

to the shore, are characteristic of this type of coast. The possible origin of straight coasts and of curves of different radius by wave-action is considered briefly, and the elaborate essay concludes with some remarks on special features of coasts bordering the open sea. The memoir represents a great mass of work, but the discussion does not appear to reveal results of such importance as the author might reasonably have anticipated for his labours. A special case of the same problem is dealt with by Mr. Cleveland Abbe, junr., in his "Remarks on the Cuspate Capes of the Carolina Coast," in vol. xxvi. of the *Proceedings* of the Boston Society of Natural History. This appears to be also a purely theoretical discussion, based on maps and reports, not on actual observations; and it concludes with the hypothetical explanation that the long shallow bays between the cuspate capes are formed by the joint action of waves and of back-running eddies of the Gulf Stream working on the flat shores of detrital material.

American Geographical Monographs.—In March, 1895, the National Geographic Society of Washington commenced to issue a series of 'National Geographic Monographs,' to be published by the American Book Company monthly during the school year, for the special benefit of teachers and students. They are intended to supplement text-books by supplying the most recent information as to geographical theory and discovery. The three first numbers are of general interest, the others more particular, dealing in detail with particular features of the United States. Major Powell is the author of the three monographs on 'Physiographic Processes,' 'Physiographic Features,' and 'Physiographic Regions of the United States.' His definition of physiography—"a description of the surface features of the earth, as bodies of air, water, and land," is that more usually applied in this country to physical geography. The processes of physical geography are explained concisely as motions in the three envelopes of air, water, and rock, which enclose and conceal the unknown inner mass of the globe. Vertical changes in the land are due to *vulcanism* and *diastrophism* (a term including upheaval and subsidence), while horizontal movements involving the transport of material are termed *gradation*. When speaking of physiographic features, Major Powell considers plains and plateaus, mountains, hills, stream channels and cataracts, fountains, caverns, lakes, marshes, coast-forms, and islands. These are all classified according to origin into the three classes—vulcanic, diastrophic, and gradational. Subaqueous forms are not considered. The 'Physiographic Regions of the United States' comprise four slopes—to the Atlantic, the Gulf of Mexico, the Pacific, and the Great Lakes. A map is given, showing a minuter subdivision into plains, plateaus, and mountains, the various groups being distinguished by special names. The original name of *Stony mountains* is restored to the mountains which extend through Washington and Wyoming, the later name of *Rocky mountains*, having been so loosely applied as to lose all value as a definite term, is used as a general indication of the whole range of regions. It seems a pity that, for the purpose of a new classification which aims at being scientific and exhaustive, the continent of North America was not taken as a unit instead only of its central zone arbitrarily truncated by political boundaries. Practically, this difficulty would be felt most by teachers in the regions bordering on the frontiers, but theoretically the matter is of some importance, as the subdivision by natural regions of an artificial unit, however large that unit may be, can never be logically complete.

GENERAL.

Hints to Travellers—Museum of Paris.—A series of public lectures and conferences by the professors and assistants of the Paris Museum was carried on during 1893, with the object of affording travellers thorough instruction in

scientific collecting. These lectures have been collected and arranged by M. H. Filhol, and published by the Minister of Education. The work extends to 303 pages, and deals with anthropology, botany, geology, and all branches of natural history and comparative anatomy. The treatment of the eighteen chapters varies greatly, and it is difficult to tell how much of each chapter is due to any particular professor or to M. Filhol himself. In most cases certain data are given as to the habitats of the creatures concerned, sometimes extending to great length, and of a very popular nature. For others, *e.g.* Némathèlminthes, we find that these "are worms living in a free condition or as parasites. When free they are found in fresh water, in salt water, or in moist earth." The botanical notes appear to be almost entirely taken from Verlot's work, 'Guide du Botaniste herborisant.' But a new method is given of breaking off flowering branches growing at the top of inaccessible trees, viz. by firing at the branch to which they are attached. Many of the zoological notes are also due to 'Le Naturaliste,' by M. L. Vaillant. The use of acetate of soda is recommended for preserving fish and other specimens; and dredging apparatus, labels, etc., are taken up in great detail. The work is neither an introduction to the study of all these various sciences, nor a concise, short, and practical guide to collecting, but a combination of both. It is somewhat strange that Livingstone's name should be spelt wrongly.

OBITUARY.

General James T. Walker, R.E., C.B., F.R.S.

By the President.

The death of General James T. Walker, R.E., C.B., F.R.S., LL.D., which took place on the 16th of February, is a very serious, and in some respects an irreparable, loss to our Society.

There are few men who have, during a service of upwards of fifty years, worked with such zeal and industry, and with such signal ability for the public interests and for the good of his country. Born in 1826, James Walker was the son of Mr. John Walker, of the Madras Civil Service. Passing at Addiscombe in December, 1844, he was appointed to the Bombay Engineers, and arrived in India on May 10, 1846. His active service commenced with the second Punjab campaign. He was field engineer at the second siege of Multan. When the town was stormed, he was in charge of a party of fifty sappers and miners. While charging the Mohon Gate a powder magazine exploded, killing eleven and wounding thirty-three of his party. Dashing through the blazing woodwork and falling walls, Lieut. Walker, at great personal risk, succeeded in extricating three of the party from the *débris*. He also served at the battle of Gujerat, and in the subsequent pursuit. From 1849 to 1853 he was engaged on the military reconnaissance of the Trans-Indus region from Peshawur to Dera Ismail Khan, arduous work well performed, and all the more meritorious because it was executed single-handed, in a very disturbed region. During this period he served with distinction in many of the encounters with hill tribes on the frontier; and he completed a military survey over 8761 square miles.

On December 1, 1853, Lieut. Walker became an assistant in the Great Trigonometrical Survey of India, under Sir Andrew Waugh, his first employment being the measurement of the Chach base near Attock. The Indus series connected the Chach and Karachi bases, and Walker had charge of the northern section. He was occupied with this work when the mutinies broke out in 1857.

Walker was then attached to Sir Neville Chamberlain's moveable column. At the siege of Delhi he had been told off to blow up the Kashmir gate, but he was severely wounded, and afterwards was attacked by cholera. He was promoted to the rank of captain in December, 1857, and of major in 1858.

Returning to his surveying duties at the close of the war, he resumed work on the Indus series, which was completed in 1860, and he was afterwards employed on the Jogi Tila meridional series. On the completion of this work, the Surveyor-General wrote to him in the following terms:—"The brilliant success which invariably attends your undertakings is a proof of the high professional qualifications, the foresight and judgment which you bring to bear on the important geodetical work on which you are engaged." During 1860 he served in the Mahsud Waziri Expedition. Captain Walker had become a Fellow of this Society in 1859, and in 1862 he contributed his admirable paper on the highland region adjacent to the Trans-Indus frontier (*R.G.S.J.*, vol. xxxii. p. 303).

On March 12, 1861, Major Walker succeeded Sir Andrew Waugh as Superintendent of the Great Trigonometrical Survey of India, and in the next two years the three last meridional series in the north of India were completed. Walker's first independent work was the measurement of the Vizagapatam base line, which was completed in 1862. To show the accuracy of the calculations, it may be mentioned that the difference between the measured length of the base line and the length as computed from triangles, commencing 480 miles away at the Calcutta base line, and passing through dense jungle, was half an inch. A revision was next undertaken of the triangulation of Lambton in the south of India, work executed during the early part of this century, with re-measurements of the base lines. In February, 1864, Walker attained the rank of lieut.-colonel.

On his way home on leave in 1864, Colonel Walker visited Russia, and established very friendly relations with the geodesists of the Russian survey. Through this wise step he was well supplied with geographical information from Petersburg, and there was a cordial feeling of co-operation between the officers of the two services. For instance, when Colonel Walker undertook a series of pendulum observations, the convertible pendulums were lent him by the Imperial Academy of Sciences at Petersburg. Colonel Walker was again on leave in 1871–72, when he, in conjunction with Sir Oliver St. John, fixed the difference of longitude between Tehran and London. He also made a thorough investigation of the condition of the plates of the Indian Atlas remaining in England, and wrote an important memorandum on the projection and scale of the atlas. On his return he gave much attention to the question of the dispersion of unavoidable minute errors in observations for latitudes, longitudes, and azimuths, to obtain the closest approach to accuracy. At about the same time a gigantic work was undertaken, the 'Account of the Operations of the Great Trigonometrical Survey of India,' to consist of twenty volumes. The first nine were published by General Walker, and the first appeared in 1871. It contains his introductory history of the early operations of the survey, and his account of the standards of measure and base lines. The second volume, also mainly by Colonel Walker, consists of an historical account of the triangulation, with descriptions of the method of procedure, and of the instruments employed. The fifth volume is an account of the pendulum observations by Colonel Walker. The superintendent's work as a geographer was only second in importance to his geodetic labours. His office at Dehra Dun was a hive of ceaseless and intelligent industry. Explorers were trained, survey parties were organized for every military expedition, native surveyors were despatched to make discoveries, and their work was reduced and utilized. Numerous valuable maps were published, and Walker's map of Turkistan went through many editions, and was the leading authority for

upwards of twenty years. On January 1, 1878, Walker, who had become a full colonel in 1869, undertook the exceedingly laborious post of Surveyor-General of India, in addition to the work of superintendent of the Great Trigonometrical Survey; and he continued to transact the whole business of the combined surveys until he retired.

After a most arduous service of twenty-two years as Superintendent, Walker retired, having become a major-general in December, 1878, and a lieut.-general in 1881. The date of his retirement was February 12, 1883, and in January, 1884, he was promoted to the rank of general. He was F.R.S. and LL.D. of Cambridge.

Colonel Tanner, one of the most distinguished of his colleagues, thus writes of Walker's services—"He was one of those who took up no subject without mastering it thoroughly. As the head of an important department, he made himself well acquainted with the intricate details of every branch of surveying, whether surveying in its ordinary sense or the more abstruse details of geodesy. I think I may say that he was looked up to by all under him as one who could advise every one on special questions. He could conduct, to the very best advantage, the most intricate and exact measurements, and at the same time could take a broad-minded view of the rougher systems of exploration and reconnaissance, which, under his *régime*, were pushed far over the Indian frontiers into Central Asia. General Walker's own speciality was rigorous trigonometrical surveying, but this did not lead him to favour that branch of the work more than the other. While he was Surveyor-General of India it must be acknowledged that every class of work was greatly improved, and brought to a higher state of perfection. No Surveyor-General has so left his mark on every branch of the survey of India. Under General Walker's administration, foreigners and Englishmen alike came to recognize the high excellence of the maps and records turned out by his officers."

Colonel Woodthorpe, C.B., writes that General Walker "was a just and appreciative chief, and a true friend, whose keen interest in all I have done under his successors was always a great encouragement to me. He was one of those whose friendship and approval any man might be proud to win. His kindness and patience with others having less knowledge than he possessed were very marked, and no one in difficulty turned to him for advice in vain. I have the liveliest recollection of many valuable hints given in friendly conversation with no assumption of superior knowledge."

No less affectionate are the reminiscences of Colonel Godwin Austen. Speaking of co-operation with General Walker in the compilation of the first map of Central Asia, he writes: "I shall never forget the great pleasure of meeting him daily, and how much I learnt from him. It was when engaged on such researches that Walker's knowledge and his intense love for geographical study showed itself."

General Walker saw the principal triangulation of British India completed during his incumbency, including ten base lines and 3668 stations, those on the plains being towers 30 to 40 feet high. As the Duke of Argyll well observed in his despatch of 1871, this great survey, as a record of accurate geodetical measurement and of arduous services well performed, will yield to none that has hitherto been published by any European nation either in interest or in scientific importance, while the final harmonizing of results necessitated the most elaborate calculations that have ever been undertaken for the reduction of triangulation. It was no small honour to have been the leader, during nearly a quarter of a century, of that devoted band of able public servants which composed the staff of the survey —*primus inter pares*. These men combine the knowledge and habits of thought of a Cambridge wrangler with the energy, resource, and presence of mind of an explorer or a backwoodsman; adding also all the gallantry and devotion which

inspire the leader of a forlorn hope. The danger of service in the jungles and swamps of India, with attendant anxiety and incessant work, is greater than that encountered on a battle-field; the percentage of deaths is larger, while the sort of courage that is needed is of a higher order, yet the well-earned rewards are withheld. When General Walker retired, his great services received no recognition whatever. Nevertheless, the story of the Great Survey forms one of the proudest pages in the history of English domination in the East.

After his retirement, General Walker gave himself little rest. In 1885 he became a member of our Council, and for ten years he has been one of its most active and most valued labourers in the field of geography. In the same year he was President of the Geographical Section of the British Association at Aberdeen. He kept up a large correspondence with geodesists throughout the world, always ready to give advice and to supply information. Only last Christmas he received a letter from the Astronomer at the Cape of Good Hope, thanking him for a copy of his paper on "India's Contributions to Geodesy." "There are few men," wrote Mr. Gill, "who can esteem it more highly than I do. If you will allow me to say so, I have never seen a summary of such a vast mass of work presented in so clear, neat, and complete a manner. Nothing that it is essentially necessary to know is omitted, and yet it seems almost impossible to have rendered an account of such a vast mass of detail in so small a space." In furthering the work of our Society, he was zealous and active. He superintended the construction of maps, drew up numerous reports and memoranda, gave much appreciated advice, and afforded invaluable counsel to young explorers. In 1885 he read a paper on the work of one of the most eminent of the native Trans-Himalayan explorers in Tibet, which elicited a full and valuable discussion (*R.G.S.J.*, ii., vol. vii. p. 65). In 1886 he discussed the question of the name given to Mount Everest, proving that the name "Gaurisanhar," applied to it by the Schlagentweits, was erroneous, and establishing his point by closely reasoned and conclusive argument (*R.G.S.J.*, ii., vol. viii. pp. 88 and 257). His papers on the Lun river of Tibet as the source of the Irawadi or Salwin (*R.G.S.J.*, ii., vol. ix. p. 352), and on the hydrography of South-East Tibet (*R.G.S.J.*, ii., vol. x. p. 577), are admirable specimens of the best kind of speculative geography. General Walker's latest service was his taking charge of the geodetic work of the International Geographical Congress last summer.

The work done by this illustrious geographer and geodesist, during half a century of service, is as prodigious in amount as it is valuable in quality. He will be missed by many friends, but by none more than by his colleagues of this Society. Ever ready with advice and help, punctual and conscientious in all he undertook, never sparing himself when there was work to be done, by our Council his loss will long be felt, and at present it is irreparable. James Walker was the most modest of men. His name ought to be in the list of our Gold Medallists; but he thought that the consciousness of having done his duty was a sufficient reward. On more than one occasion he refused to allow his name to be put in nomination for one of the royal awards. The matter was strongly urged upon him in 1894. His answer was, "I only did my duty." This most inadequate memoir shows what that unrewarded duty was, and how it was done.

General Walker was married in India, on April 27, 1854, to Alicia, daughter of General Sir John Scott, K.C.B., by Alicia, granddaughter of Dr. W. Markham, Archbishop of York. His widow survives him, and he leaves one son, Herbert, a promising young officer in the Royal Engineers, and three daughters to mourn his loss.

The Right Hon. Hugh C. E. Childers, F.R.S.

The Royal Geographical Society, as a body, shares in the general regret experienced at the death of Mr. Childers, which took place on January 29, he having been for many years (since 1858) a member of the Society. At the time of his death he was a member of the Council. Mr. Childers was born in 1827, being the son of the Rev. Eardley Childers, of Cantley, in Yorkshire. Having received his education at Cheam School and Trinity College, Cambridge, he sailed in 1850 for Australia, where he remained until 1857, taking part in the political life of the colony of Victoria. It was as agent-general for this colony that he returned to England in the latter year, soon after which (1860) he was first returned as M.P. for Pontefract, which borough he represented uninterruptedly for twenty-five years. The general election of 1885 having left him without a seat, he was a few months later returned for South Edinburgh, retaining the seat until his retirement from public life, due to failing eyesight, in 1892. Into the details of his political career, in the course of which he was in turn at the head of the Admiralty, War Office, Exchequer, and Home Office, we cannot enter here. Suffice it to say that his business-like capacities and honesty of purpose were generally acknowledged, and that he was sincerely attached to the Church. Besides being at various times a director of several public companies, he had been chairman both of the Great Indian Peninsular Railway Company and of the Royal Mail Steam-packet Company. He was twice married, his second wife having died only last year.

Captain W. W. May, R.N.

By Clements R. Markham, C.B., F.R.S.

Captain Walter Waller May, R.N., whose death is announced as having taken place on February 14, although he was not a Fellow of the Society, was an Arctic explorer of some standing. He served as a mate in the *Resolute* under Captain Austin, in the expedition of 1850-51, taking an active part in the sledging operations. From 1850 to 1854 he was first lieutenant of the *Assistance* in Sir E. Belcher's expedition, and went over 600 miles in seventy-eight days in a sledging journey. For these services he was promoted to the rank of commander, and soon afterwards he retired from active service. He became a retired captain in October, 1869. Captain May was an eminent water-colour painter. He published a series of sketches made during the voyage of the *Assistance*; and drew the illustrations for M'Clintock's voyage of the *Fox*. The bas-reliefs on the pedestal of Franklin's statue, in Waterloo Place, are also from his designs. For many years he exhibited his water-colour paintings, which fetched high prices. Captain May was appointed keeper of the Painted Hall at Greenwich last year. He was always ready to render services to our Society, and was especially useful in bringing together and arranging the collection of pictures for the Franklin commemoration. He formed one out of the fifteen old Arctic officers who were the guests of the Geographical Club on May 20, 1895. Several surviving old messmates will deplore his loss, and among them the present writer, who served with Captain May in the Arctic Regions, and was with him during a short exploring journey round Griffith island in June, 1851.

MEETINGS OF THE ROYAL GEOGRAPHICAL SOCIETY, SESSION 1895-1896.

Fifth Ordinary Meeting, January 27, 1896.—CLEMENTS R. MARKHAM, ESQ., C.B., President, in the Chair.

THE PRESIDENT said: Before proceeding to the paper of the evening, there are one or two remarks I think it desirable to make. In the first place, we must congratulate Mr. Borchgrevink on having succeeded in his wish to proceed this year to the Antarctic Regions. I understand that there will be a vessel going out for whaling purposes, and that he, with a small scientific staff, will take a passage in her, and be landed in Antarctica, probably near Cape Adare, where he will winter with his companions, and attempt to proceed into the interior on ski, or Norwegian snow-shoes, and he will be taken off again in the succeeding spring. I believe he intended to have worked with Mr. Astrup, but I regret, and we all regret, that that gallant Arctic explorer, who received one of our awards last year, met with a fatal accident in crossing one of the fjelds in Norway this winter.

I understand also that the Germans and Belgians are making great efforts to raise funds for an Antarctic expedition. Our Government has been unable to meet the wishes of scientific men in this respect, but I think we ought really to make one great effort to obtain funds for an adequate private expedition. I cannot help feeling that one good answer to the foolish abuse and invective of the foreign press, would have been for our Government calmly to fit out and despatch a well-equipped Antarctic expedition, which would be then doing a work common enough in this country, but not so common in the countries which have been abusing us. We should be doing work not only for ourselves, but for the benefit of the whole civilized world. You will also be glad to hear that M. Andrée is making good progress in his preparations for crossing the North Pole in a balloon, and we have had the pleasure of extending assistance in various ways to his Excellency, the Swedish minister, in order that he may give timely warning of the possible appearance of this balloon, to all the circumpolar stations of Alaska, the Hudson's Bay Company, and of Siberia. The commanders of these stations will be asked to warn the natives that the balloon is not a devilish or dangerous thing, but that it contains scientific people; and the natives will be requested to assist them in every possible way. I am glad to know that we have present with us this evening one of the dwellers in a circumpolar station, the Russian Consul at Vardoe, who sent out two expeditions for the relief of Captain Wiggins, and gave great assistance to Mr. Jackson and Mr. Trevor Battye.

ELECTIONS.—*Walter Henry Breeze; Captain Robert George Broadwood* (*12th Royal Lancers*); *F. A. Cooper; Brig.-General J. Jopp, C.B.; Harry Francis Keep; W. G. Lovell; Surg.-Major Macpherson; Captain G. O. Mennie, I.S.C.; Alfred James Schwabe.*

The Paper read was:—

"The First Crossing of the Southern Alps of New Zealand." By E. A. Fitz Gerald, Esq.

Sixth Ordinary Meeting, February 10, 1896.—CLEMENTS R. MARKHAM, ESQ., C.B., President, in the Chair.

Before proceeding with the business of the evening, it is my duty to mention the loss of two members of the Council. The Right Hon. Hugh Childers, I am afraid, had been failing for a long time. He joined the Council only two years ago,

though he had been a Fellow since 1858. He took a very great interest in our work, and was particularly valuable to us in advising on all matters of finance, and we very deeply regret his loss. The other loss is due to a very different cause. I allude to Lord Lamington, who has left England to take up the Governorship of Queensland; and when we bade him farewell, we felt sure that, although he left us for some time, he would still continue to be a very warm friend of this Society and of geography.

Elections.—*H. J. Allcroft; Joseph Edward Balmer; Lieut.-Colonel John A. Bindley, J.P.; William Bisiker; George J. Bridges; James Buckle; Rev. Frederick Charles Guise Cass; Herbert William Cribb; Rev. Louis Bredin Delap, B.A.; Harry Simpson Gee, J.P.; George M. Graves; James Hodson; Thomas Harris Lloyd; Professor J. W. Lowber, LL.D.; Philip Michaelis; Alfred Wilmot New; Captain Wellesley Lynedoch Henry Paget, R.H.A.; John Rew; Christopher Turnor.*

The Paper read was:—

"Movements of the Earth's Crust." By Professor John Milne.

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By HUGH ROBERT MILL, D.Sc., *Librarian*, R.G.S.

The following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are in each case written in full:—

A. = Academy, Academie, Akademie.	Mag. = Magazine.
Ann. = Annals, Annales, Annalen.	P. = Proceedings.
B. = Bulletin, Bollettino, Boletim.	R. = Royal.
Com. = Commerce, Commercial.	Rev. = Review, Revue, Revista.
C. R. = Comptes Rendus.	S. = Society, Société, Selskab.
Erdk. = Erdkunde.	Sitzb. = Sitzungsbericht.
G. = Geography, Geographie, Geografia.	T. = Transactions.
Ges. = Gesellschaft.	V. = Verein.
I. = Institute, Institution.	Verh. = Verhandlungen.
J. = Journal.	W. = Wissenschaft, and compounds.
M. = Mitteilungen.	Z. = Zeitschrift.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half-inch. The size of the *Journal* is 10 × 6½.

EUROPE.

Alps—Structure. *Ann. G.* **5** (1896): 167–178. **Haug.**

Contribution à l'étude des lignes directrices de la chaîne des Alps. Par M. E. Haug. *With Map.*

A geographical study guided by geological divisions, and illustrated by a map showing in colour the anticlinal and synclinal axes which make up the chain.

Austria—Pelagosa. *Deutsche Rundschau G.* **18** (1896): 159–171. **Groller.**

Die Inselgruppe Pelagosa im Adriatischen Meere. Geschildert von M. Groller v. Mildensee. *With Map and Illustrations.*

Description of a visit to Pelagosa, introduced by some historical notes about the island.

Bay of Biscay—Currents. *Ann. Hydrographie* **23** (1895): 427–439. **Dinklage.**

Stromversetzungen vor der Bucht von Biscaya, auf dem Dampferwege von Ouessant nach dem Kap Finisterre. Von L. E. Dinklage.

Belgium—Aische-en-Refail. **Verhelst.**

B.S.R. Belge G. **19** (1895): 201-228, 289-332, 543-556.

Étude de Géographie locale. Aische-en-Refail. Par Ed. Verhelst. *With Plan.*

Caucasus. *Verh. Ges. Erdk. Berlin* **22** (1895): 602-611. **Arzruni.**

Herr Prof. Andreas Arzruni: Reise nach Süd Kaukasien.

Account of a journey in Southern Caucasia in 1894, with the special object of studying volcanic phenomena.

Caucasus—Central. *C.R.* **121** (1895): 839-842. **Fournier.**

Sur la géologie et la tectonique du Caucase central. Note de M. E. Fournier.

Caucasus—Daghestan. **Radde and Koenig.**

Der Nordfuss des Dagestan und das vorlagernde Tiefland bis zur Kuma. Von Dr. G. Radde und E. Koenig.—Dr. A. Petermann's 'Mitteilungen,' Ergänzungsheft No. 117. Gotha: Justus Perthes, 1895. Size 11 × 8, pp. iv. and 66. *Map.*

This will be specially noticed in the *Journal.*

Danube. **Schweiger-Lerchenfeld.**

Die Donau als Völkerweg, Schiffahrtsstrasse und Reiseroute. Von Amand Freiherr v. Schweiger-Lerchenfeld. Vienna, etc.: A. Hartleben, 1896. Size 9½ × 7, pp. viii. and 950. *Maps and Illustrations. Price* 17*s.* 6*d.*

A popular and richly illustrated treatise on the Danube from its source to the sea, dealing with the geographical, historical, and picturesque aspects of the river-basin, and with the navigation and trade of the river itself.

Faröes. **Andersen.**

Færøerne, 1600-1709. Af N. Andersen. Copenhagen: G. E. C. Gad, 1895. Size 8½ × 5½, pp. 460. *Map and Plan. Price* 5*s.* 6*d.*

The history of the Faröes in the seventeenth century, with notes on the geographical conditions and the trade of the islands.

France—Anthropology. *Ann. G.* **5** (1896): 156-166. **Collignon.**

De l'Auvergne à l'Atlantique, étude anthropologique. Par M. le Dr. R. Collignon. *With Maps.*

France—Demography. *B.S. d'Anthrop. Paris* (4) **5** (1894): 648-684. **Chervin.**

La situation démographique de la France en Europe. Par M. le Dr. Chervin.

A study of the fluctuations of population in France.

France—Tours. *S.G. Tours, Revue* **12** (1895): 13-35. **Chauvigné.**

Géographie historique et descriptive de la Champagne tourangelle et de la Brenne. Par Auguste Chauvigné.

France—Vosges—The Faucilles. *B.S.G. de l'Est* (1895): 88-97. **Fournier.**

Géographie régionale. Les Faucilles. Par M. le Dr. A. Fournier.

Germany—Alsace-Lorraine. **Boller.**

Untersuchungen über die Bodentemperaturen an den forstlich-meteorologischen Stationen in Elsass-Lothringen. Von Wilhelm Boller.—Geographische Abhandlungen aus den Reichslanden Elsass-Lothringen . . . herausgegeben von Prof. Dr. G. Gerland. Zweites Heft. Pp. 185-266. Stuttgart: E. Schweizerbart, 1895. Size 9½ × 6. *Plates.*

Germany—Alsace—Rainfall. **Rubel.**

Die Niederschlagsverhältnisse im Ober-Elsass. Von Otto Rubel.—Geographische Abhandlungen aus den Reichslanden Elsass-Lothringen . . . herausgegeben von Prof. Dr. G. Gerland. Zweites Heft. Pp. 267-358. Stuttgart: E. Schweizerbart, 1895. Size 9½ × 6. *Map.*

Germany—East Prussia. *G.Z.* **1** (1895): 679-685. **Tetsner.**

Zur Besiedelung und Germanisierung Deutsch-Litauens. Von F. Tetsner.

Germany—Forests. **Höck.**

Laubwaldflora Norddeutschlands. Eine pflanzen-geographische Studie. Von Dr. F. Höck.—Forschungen zur deutschen Landes- und Volkskunde . . . herausgegeben von Dr. A. Kirchhoff. Neunter Band. Heft 4. Stuttgart: J. Engelhorn, 1896. Size 9½ × 6½, pp. [67].

On the deciduous forests of Northern Germany.

Germany—Lower Vistula. *Deutsche Rundschau G.* **18** (1895): 49-61. **Zweck.**

Die untere Weichsel und ihre neue Mündung bei Schiewenhorst. Von Dr. A. Zweck. *With Map and Illustration.*

A full account of the recent change in the Vistula, brought about by the new artificial channel. See vol. vi. p. 565.

Germany—Saxony. *Deutsche G. Blätter* **18** (1895): 309–322. **Gebauer.**

Die Waldungen des Königreichs Sachsen. I. Von Heinrich Gebauer. *With Map.*

On the forests of Saxony.

Holland to Russia. **Jefferson.**

Awheel to Moscow and back. The Record of a Record Cycle Ride. By Robert L. Jefferson. With a Preface by Lieut.-Colonel A. R. Savile. London: Low & Co., 1895. Size 8 × 5½, pp. xii. and 172. *Illustrations. Price* 2*s. Presented by the Publishers.*

The sole object of the writer was to make the journey from London to Moscow and back on a bicycle in fifty days. It reflects credit on the forbearance of innkeepers and wayfaring peasants, and on the toleration of the Russian police, that he succeeded in doing so.

Iceland—Reykjanes. *Globus* **69** (1896): 77–81. **Thoroddsen.**

Ergebnisse von Dr. Thoroddsen's Forschungen auf Reykjanes. Aus dem Isländischen im Auszuge mitgeteilt. Von M. Lehmann-Filhés. *With Map.*

Italy—Sicily. **Vuillier.**

Tour du Monde **67** (1894): 1–64; **68** (1894): 289–336; **1** *N.S.* (1895): 133 . . . 553.

La Sicile, impressions du présent et du passé. Par M. Gaston Vuillier. *With Illustrations.*

Lipari Islands. **Ludwig Salvator.**

Die Liparischen Inseln. Fünftes Heft: Filicuri. Prague: H. Mercy, 1895. Size 16½ × 13, pp. viii. and 38. *Map and Illustrations. Presented by the Archduke Ludwig Salvator.*

The luxurious typography of this work has already been commented upon; the geographical bearing will be noticed in a special review when the book is completed.

Mediterranean—Malta. *Deutsche Rundschau G.* **18** (1895): 1–6; 61–68. **Lenz.**

Die Maltagruppe. Von Oskar Lenz. *With Illustrations.*

Norway—Finmarken. **Reusch.**

Folk og natur i Finmarken. Af Hans Reusch (Med et tillæg: Uddrag af Keilhaus "Reise i Øst- og Vest-Finmarken"). Christiania: T. O. Brøgger, 1895. Size 9½ × 6½, pp. 176. *Map and Illustrations. Presented by the Author.*

Russia—Geological History. *Ann. G.* **5** (1896): 179–192. **Karpinsky.**

Sur le caractère général des mouvements de l'écorce terrestre dans la Russie d'Europe. Par M. Karpinsky. *With Illustrations.*

Abstract of a paper published in Russian in the *Bulletin* of the Academy of Sciences of St. Petersburg, 1894, illustrated by numerous sketch-maps, showing from geological evidence the distribution of land and water over Russia at different geological epochs.

Spain—Historical. *Nouv. Archives Miss. Sci.* **6** (1895): 597–635. **Dezert.**

Mission en Espagne (1890). Les archives des Indes à Séville, les archives du consulat de Cadix (1894). Par M. Desdevises du Dezert.

Sweden—Gothland Flora. **Sernander.**

Studier öfver den Gotländska vegetationens utvecklingshistoria. Af Rutger Sernander. Upsala, 1894. Size 10 × 6½, pp. 112.

Sweden—Magnetic Conditions. **Carlheim-Gyllensköld.**

Bihang K. Svenska Vet.-A. Handlingar **20** (1895): 1–32.

Déterminations des éléments magnétiques effectuées sur la glace de quelques lacs en Suède pendant l'hiver, 1889. Par V. Carlheim-Gyllensköld.

The magnetic observations here discussed were made on the ice in the middle of lakes during winter, so as to be as far as possible from any local disturbances.

United Kingdom, England—Surrey. **Barrett.**

Surrey: Highways, Byways, and Waterways. Written and Illustrated by C. R. B. Barrett. London: Bliss, Sands, & Foster, 1895. Size 10½ × 8, pp. xvi. and 252. *Illustrations.*

United Kingdom—Ireland. *P.R. Irish A.* (3) **3** (1895): 587–649. **Browne.**

The Ethnography of the Mullet, Inishkea Islands, and Portacloy, County Mayo. By Charles R. Browne, M D. *With Plates.*

United Kingdom—Meteorology. ———

Official No. 117. Meteorological Observations at Stations of the Second Order for the year 1891. With Frontispiece, Map, and Appendix, giving results for certain Stations for the 15 years 1876–1890. Published by direction of the

Meteorological Council. London: Eyre and Spottiswoode, 1895. Size 12½ × 10. *Price* 30*s*. *Presented by the Meteorological Office.*

ASIA.

Asia—Geomorphology. *G.Z.* **2** (1896): 7–25. **Naumann.**

Die Grundlinien Anatoliens und Centralasiens. Von Dr. Edmund Naumann. *With Maps.*

A comparison between the fundamental structural lines of Asia Minor and the main mass of Asia.

Asia Minor. **Diest and Anton.**

Neue Forschungen im nordwestlichen Kleinasien. Von W. v. Diest, und M. Anton, mit Beiträgen von Leutnant Graf Götzen, Dr. A. Körte und Dr. G. Türk. —Dr. A. Petermann's 'Mitteilungen.' Ergänzungsheft Nr. 116. Gotha: Justus Perthes, 1895. Size 11 × 7½, pp. 132. *Maps. Price* 8 *mark.*

This will be specially noticed.

Asia Minor. **Naumann.**

Reisen in Anatolien. Von Dr. Edmund Naumann. Sonder-Abdruck aus Band LXVII. Nr. 18 u. 19 des Globus. Brunswick: F. Vieweg & Sohn, [1895]. Size 12½ × 9½, pp. 12. *Maps and Illustrations. Presented by the Author.*

Asia Minor—Phrygia. *Nouv. Archives Miss. Sci.* **6** (1895): 425–596. **Radet.**

En Phrygie. Rapport sur une mission scientifique en Asie Mineure (août—septembre 1893). Par M. Georges Radet. *With Maps and Plates.*

Central Asia. **Dutreuil de Rhins and Grenard.**

A travers le Monde (*Tour du Monde*) (1896): 1–4.

Mission scientifique Française dans la Haute-Asie. [M. Dutreuil de Rhins and M. Fernand Grenard.] *With Map and Illustrations.*

Central Asia—Bokhara. *Rev. Scientifique* (4 S.) **5** (1896): 145–146. **Laurent.**

Une visite à la prison de Bokhara (Asie Centrale). Par M. Émile Laurent.

China—Climate. *Deutsche Rundschau G.* **18** (1895): 97–107. **Krebs.**

Das Klima Ost-Asiens in weltwirthschaftlicher und sanitärer Beziehung. Von Wilhelm Krebs. *With Maps.*

The maps show the annual rainfall of China for several representative years.

China—Yang-tse-Kiang. *Verh. Ges. Erdk. Berlin* **22** (1895): 672–675. **Hirth.**

Herr Prof. Friedrich Hirth. Zwei Jahre am Yangtze-Kiang.

China—Yunnan. *Ann. G.* **5** (1896): 234–241. **Roux.**

Lettre sur le Yunnan. Par M. Émile Roux. *With Map.*

M. Roux was the companion of Prince Henri d'Orleans in his recent remarkable journey, and this letter includes an account of their trip from January 26, 1895, when they left Hanoi, until May 26, when they reached Tali-fu.

Eastern Asia. *Ann. G.* **5** (1896): 216–233. **Chavannes.**

Les résultats de la guerre entre la Chine et le Japon. Par M. E. Chavannes.

India—Botanical Survey. **Gammie and Woodrow.**

Records of the Botanical Survey of India. Vol. i. No. 5. Report on a Botanical Tour in the Lakhimpur District, Assam, by G. A. Gammie. Ditto, No. 6. Notes on a Journey from Poona to Nagotna, by G. Marshall Woodrow. Calcutta, 1895. Size 10 × 6¼.

India—Census. **Abbott.**

Census of India, 1891. Vol. xxvi. Rajputana. Part i. The Report, Imperial Tables, and Supplementary Returns. Part ii. The Provincial Tables and Remarks. By Lieut.-Colonel H. B. Abbott. Calcutta, 1892. Size 13 × 8½, pp. (Part i.) 124 and cccx., *Maps;* (Part ii.) 16 and lxxxviii.

India—Cochin. **Menon.**

Report on the Census of Cochin, 1891 A.D.–1066 M.E. In two parts. By C. Achyuta Menon, B.A., Superintendent of Census Operations. The Cochin Government Press, 1893. Size 13 × 8½, pp. viii., 146, 152, and xxii. *Presented by the Secretary of State for India.*

India—Kashmir. *J.E. India Association* **27** (1896): 22–32. **Lawrence.**

Kashmir. By Walter R. Lawrence.

India—Manipur. **Johnstone.**

My Experiences in Manipur and the Naga Hills. By the late Major-General Sir

James Johnstone, K.C.S.I. With an Introductory Memoir. London: Low & Co., 1896 [1895]. Size 9 × 6, pp. xxviii. and 286. *With Portrait, Map, and Illustrations. Price* 16*s*. *Presented by the Publishers.*

This will be noticed with other books on India.

India—Punjab. **Gore.**

Lights and Shades of Hill Life in the Afghan and Hindu Highlands of the Punjab. A Contrast. By F. St. J. Gore. London: John Murray, 1895. Size 9½ × 6½, pp. xx. and 270. *Maps and Illustrations. Price* 31*s*. 6*d*. *Presented by the Publisher.*

This volume, which is distinguished by exceptionally fine illustrations, will be noticed, together with other recent books on India.

India—Punjab—Lahore. **Latif.**

Lahore: its History, Architectural Remains, and Antiquities, with an account of its Modern Institutions, Inhabitants, their Trade, Customs, &c. By Syad Muhammad Latif, Khan Bahadur. Lahore: 1892. Size 10 × 6½, pp. xiv., vi., iv., 426, and xii. *Plan and Illustrations. Presented by the Author.*

India—Survey of India Department.

General Report on the Operations of the Survey of India Department administered under the Government of India during 1893–94. Prepared under the direction of Colonel Sir Henry R. Thuillier, Surveyor-General of India. Calcutta, 1895. Size 13 × 8½, pp. vi., 134, and cxviii. *Maps and Frontispiece. Presented by the Surveyor-General of India.*

The work of the Survey recorded in this report was noticed in the *Journal*, vol. vi. (1895), pp. 27–31.

India—Travencore. **Aiya.**

Report on the Census of Travancore taken . . . on the 26th February, 1891—16th Masy 1066 M.E. along with the Imperial Census of India. By V. Nagam Aiya, B.A., etc. Vol. i., Report; vol. ii., Appendix. Madras: Addison & Co., 1894. Size 8½ × 5½, pp. (vol. i.) xx. and 796; (vol. ii.) 4 and 1056. *Maps, Diagrams, etc. Presented by the Secretary of State for India.*

These volumes give the statistical tables of the Census of Travancore, illustrated by diagrams and population maps, and accompanied by an elaborate report on the people, containing much information as to the manners and customs of the various castes.

Japanese Alps. **Weston.**

Exploration in the Japanese Alps, 1891–94. From the *Geographical Journal* for February, 1896. By the Rev. Walter Weston, M.A. Size 10 × 6½, pp. [26]. *Map and Illustrations.*

Japanese Architecture. **Levieux.**

Essai sur l'Architecture Japonaise. Par Fernand Levieux. Extrait du 'Bulletin de la Société Royale Belge de Géographie,' 1895, No. 3. Brussels, 1895. Size 9 × 6, pp. 26. *Illustrations. Presented by the Author.*

Japan—Formosa. *Aus allen Weltteilen* **27** (1895): 33–40: 66–76. **Panckow.**

Die Bevölkerung Formosas. Von Hellmuth Panckow. *With Illustrations.*

Java—Batavia. *Ann. Hydrographiques* (2) **17** (1895): 80–90. **Oudemans.**

Longitude de Batavia. Par J.-A.-C. Oudemans.

This paper is accompanied by appendices giving the longitudes from recent determinations of a number of important places in the far East.

Korea. *Globus* **68** (1895): 381–383. **Arnous.**

Gewichte, Masse, Kompass und Zeiteinteilung in Korea. Von H. G. Arnous, Fusang.

On the units of measurement in Korea.

Malay Archipelago and Pacific Islands. **Schneider.**

Deutsche G. Blatter **18** (1895): 372–386.

Carl Ribbes Reisen in der Südsee. Von Professor Dr. Oskar Schneider.

Notes on the journeys of Herr Carl Ribbe for natural history observations in the Malay archipelago and neighbouring islands of the Pacific.

Malay Peninsula. **Swettenham.**

Malay Sketches. By Frank Athelstane Swettenham. London: John Lane, 1895. Size 8 × 5½, pp. xii. and 290. *Price* 5*s*. *Presented by the Publisher.*

The author states that "These pages contain no statistics, no history, no geography, no science real or spurious, no politics, no moralizing, no prophecy,—only an attempt to awaken an interest in an almost undescribed but deeply interesting people." This in a series of bright essays he succeeds in doing; but geography is not exclusively a matter of maps and measurements, and unconsciously, it may be, Mr. Swettenham furthers geography not a little by his vivid portraiture of the people and their surroundings.

Persia. **De Morgan.**
Mission Scientifique en Perse. Par J. de Morgan. Tome Second. Études géographiques. Paris: E. Leroux, 1895. Size 11½ × 9, p. 334. *Illustrations.*
This book will be specially noticed in the *Journal*.

Siam. **Smyth.**
Notes on a Journey to some of the South-Western Provinces of Siam. By H. Warington Smyth, LL.B., etc. From the *Geographical Journal* for November and December, 1895. Size 10 × 6½, pp. 44. *Map and Illustrations.*

Siberia—Surgut. *Deutsche Rundschau G.* **18** (1895): 114–123. **Stenin.**
Der Kreis Surgut in West-Sibirien. Von Peter von Stenin in St. Petersburg. *With Illustrations.*
Translated from vol. 10 of the publication of the Western Siberian branch of the Imperial Russian Geographical Society.

Straits Settlement. *Imp. and Asiatic Quarterly Rev.* (3) **1** (1896): 90–110. **Pickering.**
The Straits Settlement.—I. Its Early History. By W. A. Pickering, C.M.G.

Sumatra—Toba Lake. **Pleyte.**
De Verkenning der Bataklanden. Eene Bijdrage tot de Geschiedenis der Ontdekking van het Toba-Meer. Door C. M. Pleyte Wzn. Overgedrukt uit het "Tijdschrift van het Koninklijk Nederlandsch Aardrijkskundig Genootschap, Jaargang, 1895." Leiden: E. J. Brill, 1895. Size 9½ × 6, pp. 42. *Map. Presented by the Author.*

Tibet—Kuen-lun. *M.G. Ges. Wien* **38** (1895): 497–526. **Bogdanowitch.**
Einige Bemerkungen über das System des Kwenlun. Von K. Bogdanowitch. *With Map.*

Turkey in Asia—Kerbela. *Blackwood's Mag.* (1896): 287–293. ———
A Pilgrimage to Kerbela.
The visit to Kerbela here described took place during Muharran when the fanaticism of the Shiah Mohammedans reaches a climax.

AFRICA.

African Explorers. *Imp. and Asiatic Quarterly Rev.* (3) **1** (1896): 75–89. **Oliver.**
The African Pioneers. With a Map of Île St. Marie. By Captain S. Pasfield Oliver.

Algeria and Tunis. *Nouv. Archives Miss. Sci.* **6** (1895): 399–424. **Gain.**
Mission scientifique de physiologie végétale en Algérie et en Tunisie.—Recherches relatives à l'influence de la sécheresse sur la végétation. Par M. Edmond Gain.
This will be noticed in the Monthly Record.

Canary Islands—Teneriffe. **Meyer.**
Die Insel Teneriffe. Wanderungen im canarischen Hoch- und Tiefland. Von Dr. Hans Meyer. Leipzig: S. Hirzel, 1896. Size 9½ × 6½, pp. viii. and 328. *Maps and Illustrations. Price* 8*s.*
This book will be specially noticed.

Central Africa. **Elliot.**
A Naturalist in Mid-Africa, being an account of a Journey to the Mountains of the Moon and Tanganyika. By G. F. Scott-Elliot. London: A. D. Innes & Co., 1896. Size 9½ × 6, pp. xvi. and 414. *Maps and Illustrations. Price* 16*s. Presented by the Author.*
This work will be specially noticed.

Central Africa. *B.S.R. Belge G.* **19** (1895): 557–576. **Götzen.**
La traversée de l'Afrique centrale. Par le Lieutenant Comte von Götzen.

Congo State. *B.S.R. Belge G.* **19** (1895): 397–428, 513–542. **De la Kéthulle.**
Deux années de résidence chez le sultan Rafaï. Voyage et exploration au nord du Mbomou. Par le Lieutenant Charles de la Kéthulle de Ryhove.

Congo State. *B.S.R. Belge G.* **19** (1895): 109–134, 251–276, 333–358, 577–609. **Poskin.**
Climatologie du Congo. Par le Dr. A. Poskin.
A valuable contribution to the climatology of tropical Africa.

Egypt—Historical. **Mahaffy.**
The Empire of the Ptolemies. By J. P. Mahaffy. London: Macmillan & Co., 1895. Size 8 × 5½, pp. xxvi. and 534. *Price* 12*s.* 6*d.* *Presented by the Publishers.*
A history of Egypt under the Ptolemies.

French West Africa—Sudan. **Archinard.**
Le campagne 1892-1893 au Soudan français: Rapport de M. le colonel Archinard. Supplement to the *Bulletin du Comité de l'Afrique Française.* Sixième Année. No. 1. January, 1896. Pp. 1–36. Paris. Size 12½ × 9½. *Map and Portrait.*

German East Africa. *M. deutsch. Schutzgeb.* **8** (1895): 283–310. **Widenmann.**
Bericht über die klimatischen und gesundheitlichen Verhältnisse von Moshi am Kilimandjaro. Von Dr. Widenmann.

German Policy in Africa. *Nineteenth Century* (1896): 240–248. **Gregory.**
The proposed German Barrier across Africa. By J. W. Gregory. *With Sketch-Map.*

German South-West Africa. *Globus* **68** (1895): 384–385. **Brincker.**
Zur Namenkunde von Deutsch-Süd-Westafrika. Missionar a. D., P. H. Brincker. Stellenbosch.

German West Africa—Kamerun. *M. deutsch. Schutzgeb.* **8** (1895): 277–280. **Conrau.**
Ueber das Gebiet zwischen Mundame und Baliburg. Aus einem Briefe von G. Conrau.

German West Africa—Togo. *M. deutsch. Schutzgeb.* **8** (1895): 231–271. **Doering.**
Reiseberichte von Premierlieutenant v. Doering aus den Jahren 1873 bis 1895. *With Map.*

Madagascar. *B.S. normande G.* **17** (1895): 57–75. **Mager.**
Les peuples de Madagascar. Par M. Henri Mager. *With Map.*

Madagascar. *B.S.G. de l'Est* (1895): 123–145. **Martineau.**
Madagascar. Conférence faite à la Société. Par M. Martineau.

South Africa. **Balfour.**
Twelve Hundred Miles in a Waggon. By Alice Blanche Balfour. With Illustrations by the Author. London: E. Arnold, 1895. Size 9 × 6, pp. xx. and 266. *Map. Price* 16*s.* *Presented by the Publisher.*
This is a lively and entertaining account of a pleasure trip by way of Mafeking, Victoria, Salisbury, and Chimoia to the Pungwe river and Beira. The illustrations (thirty-eight in number) by the author, though sketchy, give a very truthful and accurate idea of the country and people. No attempt is made to describe either the people or country systematically, and most of the interesting problems of Mashonaland are, apparently of set purpose, disregarded altogether; still, a very clear idea is given of ordinary bullock-waggon travelling, and the incidental notes regarding Boers and natives are true to life.

South Africa. *Blackwood's Mag.* (1895): 121–134. ——
The Big Game of South Africa.

South Africa. **Kirby.**
In Haunts of Wild Game. A Hunter-Naturalist's Wanderings from Kahlamba to Libombo. By Frederick Vaughan Kirby (Maqaqamba). Edinburgh and London: W. Blackwood & Sons, 1896. Size 9½ × 7, pp. xvi. and 576. *Portrait, Map, and Illustrations. Price* 25*s.* *Presented by the Publishers.*
A stirring story of sport, admirably illustrated, and provided with a game-map of Kahlamba and Libombo, in the north-east of the Transvaal and the neighbouring portion of Portuguese East Africa. The map distinguishes the bush-veldt proper, the lion and low country leopard district of the veldt, the foot-hills or Kloof country, and the Krantz country, in each of which there is a special type of game. The tsetse fly boundary is approximately shown.

South Africa—Mashonaland. **Knight-Bruce.**
Memories of Mashonaland. By G. W. H. Knight-Bruce. London: E. Arnold,

1895. Size 8½ × 6, pp. 242. *Frontispiece. Price* 10*s.* 6*d. Presented by the Publisher.*

The rise of the mission in Mashonaland and questions of missionary policy form the larger part of Bishop Knight Bruce's 'Memories.' There are two interesting chapters dealing with the country and the habits of the people, an appreciation of Khama and a short account of the Matabele war. The Bishop had very exceptional opportunities and long experience, and his opinions should therefore be studied by anthropologists. There is neither map nor index.

Sudan—Niam-Niam Language. **Colombaroli.**

Premiers éléments de langue A. Sandeh vulgairement appelée Niam-Niam, recueillis et co-ordonnés par A. Colombaroli. Extrait du Bulletin de la Société Khédiviale de Géographie, IV^e^ serié, No. 6. Cairo: Imp. Nationale, 1895. Size 9 × 6, pp. 100. *Presented by the Author.*

This grammar and vocabulary of the language of the Niam-Niams has been constructed by the author from his long residence amongst the people.

Tripoli and the Sudan. *Ann. G.* **5** (1896): 193–201. **d'Attanoux.**

Tripoli et les voies commerciales du Soudan. Par M. J. Bernard d'Attanoux. *With Illustration.*

Tropical Africa. **Sitta.**

Prof. Pietro Sitta. La colonizzazione dell' Africa tropicale al VI. Congress Internazionale di Geografia tenuto in Londra dal 26 luglio al 3 agosto 1895. Estratto dalla *Riforma Sociale*, Fasc. viii., anno ii., vol. iv. Turin: Roux Frassati & Co., 1895. Size 10 × 6½, pp. 16.

A report of the discussion on Tropical Africa, introduced by Sir John Kirk at the Sixth International Geographical Congress.

West Africa—Niger. *Rev. Française* **21** (1896): 41–44. **Demanche.**

La France recule au Niger: les postes d'Yola et d'Arenberg. Par G. Demanche.

West Africa—Upper Niger. *Church Miss. Intelligencer* **47** (1896): 28–30. **Nott.**

The Upper Niger and Soudan. By Lewis H. W. Nott.

NORTH AMERICA.

Biological Geography. *Texas A. Sci.* **1** (1895): 71–96. **Townsend.**

On the Bio-Geography of Mexico, Texas, New Mexico, and Arizona, with Special Reference to the Limits of the Life Areas, and a Provisional Synopsis of the Bio-Geographic Divisions of America. By C. H. Tyler Townsend.

Canada—Geological Survey. ——

Geological Survey of Canada, George M. Dawson, Director. List of Publications of the Geological Survey of Canada. Ottawa, 1895. Size 10 × 6½, pp. 52.

Canada—Statistical Year-Book. ——

The Statistical Year-Book of Canada for 1894. Tenth Year of Issue. Issued by the Department of Agriculture. Ottawa, 1895. Size 8½ × 6½, pp. vi. and 1134. *Map and Diagram. Presented by the High Commissioner for Canada.*

A specially designed map shows in a striking way the central position of the Dominion of Canada in the British Empire.

United States. ——

U.S. Department of Agriculture. Weather Bureau. Report of the Chief of the Weather Bureau, 1893. Washington, 1894. Size 12 × 9½, pp. 320. *Plans and Illustrations.*

United States—Alaska. *Science* (*N.S.*) **3** (1896): 37–45, 87–93. **Dall.**

Alaska as it was and is, 1865–1895. (The annual presidential address, delivered before the Philosophical Society of Washington, December 6, 1895, by W. H. Dall.)

United States—Arkansas. *P. Boston S. Nat. Hist.* **26** (1895): 479–488. **Marbut.**

The Geographic Development of Crowley's Ridge. By C. F. Marbut. *With Diagrams.*

This is one of the studies carried out under the guidance of Professor W. M. Davis, of Harvard, on the lines made familiar by his article on "The development of certain English rivers" in the *Geographical Journal*, vol. v. (1895), p. 127.

United States—Carolina. *P. Boston S. Nat. Hist.*, **26** (1895): 489–497. **Abbe.**

Remarks on the Cuspate Capes of the Carolina Coast. By Cleveland Abbe, junr. *With Illustrations.*

A student's study of the characteristic curves of a low detrital coast. It will be referred to in the Monthly Record along with Güttner's treatise on the 'Morphology of Coasts.'

United States—Connecticut. *American J. Sci.* (4) **1** (1896): 1–13. **Davis.**

The Quarries in the Lava Beds at Meriden, Conn. By William M. Davis.

The paper is illustrated by some interesting sections showing the relations between geological and topographical features.

United States—Eastern States. *P. Boston S. Nat. Hist.* **26** (1895): 404–414. **Bangs.**

The geographical distribution of the eastern races of the cotton-tail (*Lepus sylvaticus*, Bach.); with a description of a new sub-species, and with notes on the distribution of the northern hare (*Lepus Americanus*, Erxl.) in the east. By Outram Bangs.

An essay on the relation between species and environment.

United States—Lower Mississippi. **Griswold.**

P. Boston S. Nat. Hist. **26** (1895): 474–479.

Origin of the Lower Mississippi. By L. S. Griswold. *With Map.*

Speculations and deductions as to the changes which have taken place in the region now traversed by the Lower Mississippi.

United States—Massachusetts. *P. Boston S. Nat. Hist.* **26** (1895): 500–505. **Tilton.**

On the south-western part of the Boston Basin. By J. L. Tilton. *With Map.*

The "basin" referred to is an area of sedimentary rocks, surrounded by rocks of igneous origin.

United States—Minnesota—Rainy Lake Region. **Winchell and Grant.**

Geolog. and Nat. Hist. Survey Minnesota, **23** *Rep.*, 1894 (1895): 36–105.

Preliminary Report on the Rainy Lake gold region. By H. V. Winchell and U. S. Grant.

United States—Missouri Geological Survey. ——

Missouri Geological Survey. Vols. iv. and v., Palæontology of Missouri (Parts i. and ii.), by Charles Rollin Keyes. Vols. vi. and vii., Lead and Zinc Deposits (Sections 1 and 2), by Arthur Winslow, assisted by James D. Robertson. Jefferson City, 1894. Size 10 × 7, pp. (vol. iv.) 272, (vol. v.) 266, (vols. vi. and vii.) xxii. and 764. *Maps and Plates. Presented by the Missouri Geological Survey.*

United States—Texas. *Texas A. Sci.* **1** (1895): 25–60. **Dumble.**

The Soils of Texas—A Preliminary Statement and Classification. By E. T. Dumble, State Geologist.

The classification is accompanied by a map showing the main regions into which the state is divided with respect to soil.

United States—Virginia—Indians. **Hendren.**

Johns Hopkins' University Studies. Thirteenth Series, xi.–xii. Government and Religion of the Virginia Indians. By Samuel Rivers Hendren, PH.D. Baltimore: The Johns Hopkins Press, 1895. Size 9½ × 6, pp. 64.

SOUTH AMERICA.

Argentine Republic—Buenos Ayres. **Frers.**

Provincia de Buenos Aires. Memoria presentada a la Honorable Legislatura por el Ministro de Obras Públicas Dr. Emilio Frers, 1894–1895. La Plate, 1895. Size 10½ × 7, pp. cxl. and 380. *Maps. Presented by the Museo de la Plata, Buenos Ayres.*

Argentine—Pilcomayo. **Storm.**

El Rio Pilcomayo y el Chaco Boreal. Viajes y exploraciones por Olaf J. Storm. Buenos Aires, 1892. Size 9 × 6, pp. 152. *Map and Illustrations. Presented by the Author.*

British Guiana and Venezuela Boundary. *Nineteenth Century* (1896): 185–188. **Bolton.**

The Facts about the Venezuela Boundary. By John Bolton. *With Map.*

Central America—Nicaragua. *P. Boston S. Nat. Hist.* **26** (1895): 546–557. **Crawford.**

Cerro Viejo and its volcanic cones. By J. Crawford.

Chile. ———

Anuario hidrográfico de la Marina de Chile. Año 18. Santiago de Chile, 1895. Size 10 × 7, pp. 32 and 480. *Plates. Presented by the Chilian Hydrographic Department.*

Chile—Chillan *Globus* **69** (1896): 60–62, 74–77. **Reiche.**

Die Thermen von Chillan in Chile. Von Dr. phil. K. Reiche in Constitucion, Chile.

Nicaragua Canal. *J. Tyneside G.S.* **3** (1895): 151–160. **Colquhoun.**

Lecture on Nicaragua and its Canal. By A. R. Colquhoun. *With Illustrations.*

Peru. **Middendorf.**

Peru. Beobachtungen und Studien über das Land und seine Bewohner während eines 25-jährigen Aufenthalts. Von E. W. Middendorf. III. Band. Das Hochland von Peru. Berlin: R. Oppenheim, 1895. Size 10 × 7, pp. xvi. and 604. *Map and Illustrations. Price* 20 *mark. Presented by the Publisher.*

After a short general introduction to the mountainous region of Peru, the author considers the highlands of Central Peru, the highlands of Northern Peru, Titicaca lake, and the highlands of Southern Peru. The volume is rich in admirable illustrations. The previous parts dealt with Lima and the coast lands.

Peru. ———

Bureau of the American Republics, Washington, U.S.A., Peru. Bulletin No. 60, 1892. [Revised to May 1, 1895.] Size 9½ × 6, pp. 146. *Map and Illustrations.*

This little volume gives a brief but well-arranged description of Peru, special prominence being given to the financial and agricultural condition of the country, to mining, political divisions, and to commercial statistics.

Peru and the Amazon. **Schütz-Holzhausen.**

Der Amazonas. Wanderbilder aus Peru, Bolivia und Nordbrasilien. Von Damian Freiherrn von Schütz-Holzhausen. Zweite, durchgesehene und erweiterte Auflage, unter besonderer Berücksichtigung der vom Verfasser gegründeten tirolisch-rheinischen Kolonie Pozuzo: herausgegeben von Adam Klassert. Freiburg im Breisgau: Herdersche Verlagshandlung, 1895. Size 10 × 6½, pp. xx. and 444. *Maps, Portrait, and Illustrations. Price* 7*s.*

The story of the travels in South America of the founder of the German colony at Pozuzo in 1856.

Tierra del Fuego. **Spears.**

The Gold Diggings of Cape Horn. A study of life in Tierra del Fuego and Patagonia. By John R. Spears. New York and London: G. P. Putnam's Sons, 1895. Size 8½ × 6, pp. x. and 320. *Map and Illustrations. Presented by the Author.*

A pleasantly written travel-sketch by a New York journalist. It gives a fresh and lively description of present-day life in the southern corner of South America.

Venezuelan Boundaries. *Globus* **69** (1896): 53–55. **Sievers.**

Die Grenzen Venezuelas. Von Prof. W. Sievers; Giessen. *With Map.*

West Indies. *B.S. normande G.* **17** (1895): 165–178. **Vibert.**

Exploration aux Antilles. Par M. Paul Vibert.

This article includes notes of a visit to Haiti.

CENTRAL AND SOUTH AMERICA.

West Indies—Jamaica. *J.S. Arts* **44** (1896): 103–130. **Cundall.**

Jamaica in the Past and Present. By Frank Cundall. *With Map and Illustrations.*

West Indies—Jamaica. **Norman.**

Australasian Association for the Advancement of Science. Brisbane, 1895. A West India Island. By General Sir H. W. Norman, G.C.B., etc. Size 9 × 5½, pp. 14. *Presented by the Author.*

West Indies. *G.Z.* **2** (1896): 1–6. **Deckert.**

Politisch-geographische Betrachtungen über Westindien, unter besonderer Berücksichtigung von Cuba. Von Dr. Emil Deckert. I. Allgemeiner Ueberblick.

AUSTRALASIA AND OCEANIC ISLANDS.

Australia and Oceania. **Sievers.**

Australien und Ozeanien. Eine allgemeine Landeskunde von Professor Dr. Wilhelm Sievers. Leipzig: Bibliographisches Institut, 1895. Size 10½ × 7½, pp. viii. and 522. *Maps and Illustrations (including coloured plates). Price* 16*s.*

Australasian Colonies. **Jenks.**

The History of the Australasian Colonies (from their Foundation to the year 1893). By Edward Jenks. Cambridge: The University Press, 1895. Size 8 × 5½, pp. xvi. and 352. *Map. Price* 6*s. Presented by the Cambridge University Press.*

This compact little history, provided with a full index, gives a summary of Australian history in a concise but attractive form. It is a record full of lessons in geography, for the adaptation of a civilized race to the conditions of a new environment was never more clearly shown than in the colonization and development of Australia.

Australian Fungi. **McAlpine.**

Department of Agriculture, Victoria. Systematic arrangement of Australian Fungi, together with Host-index and list of works on the subject. By D. McAlpine, Government Vegetable Pathologist. Melbourne, 1895. Size 11 × 9, pp. viii. and 336. *Presented by the Government of Victoria.*

Marshall Islands. *Aus allen Welttheilen* **27** (1895): 1–11. **Kirchhoff.**

Die Marshall-Inseln. Von Professor Dr. Alfred Kirchhoff.

New Zealand—Year-Book. **Dadelszen.**

The New Zealand Official Year-Book, 1895. . . . By E. J. von Dadelszen, Registrar-General. Wellington, 1895. Size 8½ × 5½, pp. viii. and 554. *Map and Plates.*

This book contains full statistics of New Zealand, including a number of statistical diagrams of a kind likely to appeal to the understanding of intending emigrants who might not pay much attention to mere tables of figures.

PACIFIC ISLANDS.

Pacific Islands. ———

Parts of the Pacific. By a Peripatetic Parson. Illustrated from Drawings by the Author and from photographs. London: Sonnenschein & Co., 1896. Size 9 × 6, pp. xii. and 388. *Map. Price* 10*s.* 6*d. Presented by the Publishers.*

"The book lays no claim to being technical, but rather aims at a colloquial description of strange lands, touching upon such matters as Emigration, Missions, the Kanaka Labour Question, and the General Treatment of Natives." So the preface states the aim of this work. The places described are North Queensland, the Fiji Islands, New Zealand, the Hawaiian Islands, and the coast of North America.

Queensland. **Bicknell.**

Travel and Adventure in Northern Queensland. By Arthur C. Bicknell. With illustrations by J. B. Clark, from sketches by the author. London: Longmans & Co., 1895: size 9 × 6, pp. xvi. and 220. *Portrait. Price* 15*s. Presented by the Publishers.*

A somewhat minute account of the daily incidents of travelling in outlying parts of Queensland, with humorous illustrations.

Queensland Coast. **Norman.**

Captain Cook and his First Voyage round the World, 1768 to 1771; with special reference to his Exploration of the Queensland Coast. By His Excellency General Sir Henry W. Norman, G.C.B., etc. (Read at a meeting of the Society, October 25, 1895.) Reprinted from the *Proceedings and Transactions of the Royal Geographical Society of Australasia, Brisbane*, vol. xi. Size 9 × 5½, pp. 30. *Presented by the Author.*

Samoa. **Ehlers.**

Samoa die Perle der Südsee à jour gefasst von Otto E. Ehlers. Berlin: H. Paetel, 1895. Size 9 × 6½, pp. 200. *Frontispiece. Price* 3*s.*

South Australia—Northern Territory. **[Brown.]**

South Australia. Government Geologist's Report on Explorations in the Northern Territory. Adelaide, 1895. Size 13½ × 8½, pp. 34. *Maps, Plates, and Sections. Presented by the Secretary of State for the Colonies.*

This report will be the subject of a special note.

Victoria—Year-Book. ———

Victorian Year-Book, 1894. Containing a digest of the Statistics of Victoria, with references to the Statistics of the other Australian Colonies and other Countries. Twenty-first Year of Issue. Melbourne, 1895. Size 8½ × 6, pp. viii., 928, and lxxxvi. *Map. Presented by the Government of Victoria.*

Western Australia—Mining Handbook. **Woodward.**

Mining Handbook to the Colony of Western Australia, written especially for Prospectors and Strangers to the Colony who are interested in Mining. By Harry

P. Woodward, Government Geologist. 2nd Edit. Perth, 1895. Size 8½ × 5½, pp. vi. and 216. *Maps. Presented by the Author.*

The first edition was noticed in vol. 5 (1895), p. 92. The book has been extended, improved, and brought down to date.

POLAR REGIONS.

Antarctic. *Petermann's M.* **41** (1895): 291–293. **Larsen.**

Kapitän A. Larsens antarktische Forschung.

Criticisms of Dr. Wichmann's article in 'Petermann's Mitteilungen' on the Antarctic regions with reference to the translation of the Norwegian original, and the compilation of the map. A rejoinder by Dr. Wichmann is added.

Antarctic. *Deutsche G. Blätter* **18** (1895): 147–171; 322–350. **Ruge.**

Das unbekannte Südland. Von Professor Dr. S. Ruge.

Historical sketch of exploration in the southern hemisphere, and the search for the Antarctic continent.

Antarctic Continent. **Hedley.**

Considerations on the Surviving Refugees in Austral Lands of Ancient Antarctic Life. By C. Hedley. [Read before the Royal Society of N.S. Wales, August 7, 1895.] Size 9 × 6, pp. 10. *Presented by the Author.*

From biological reasoning, Mr. Hedley suggests "that during the Mesozoic or Older Tertiary, a strip of land with a mild climate extended across the south pole from Tasmania to Terra del Fuego, and that Tertiary New Zealand then reached sufficiently near to this Antarctic land, without joining it, to receive by flight or drift many plants and animals, as the Galapagos received their population from America, or the Azores theirs from Europe."

Antarctic Projects. *Verh. Ges. Erdk. Berlin* **22** (1895): 683–687. ———

Plan für eine deutsche Expedition zur Durchforschung der Süd-Polar-Region.

The official programme of the German Antarctic Exploration Committee.

Antarctic Regions—Kerguelen. **Murray.**

On the Deep and Shallow-water Marine Fauna of the Kerguelen Region of the Great Southern Ocean. By John Murray, D.SC., etc., of the Challenger Expedition.—*Trans. of the Royal Society of Edinburgh*, vol. xxxiii. Part ii. (No. 10). Edinburgh: R. Grant & Son, 1896. Size 12½ × 9½, pp. [158]. *Map and Illustrations. Price* 12*s.* 6*d. Presented by the Author.*

This important paper will be the subject of a special note in the Monthly Record.

Arctic Seas—Tides. *T.R. Irish A.* **30** (1895): 587–596. **Haughton.**

On the Tides of the Arctic Seas. Part ix.—On the Tides of the North-Western entrance of Robeson Channel, Grinnell Land. By Rev. Samuel Haughton, M.D.

Dr. Haughton continues his laborious investigations of the tides observed on the *Alert* in the Arctic regions twenty years ago.

Polar Exploration. *G.Z.* **1** (1895): 685–691. **Drygalski.**

Der gegenwärtige Standpunkt der Polarforschung. Von Dr. Erich von Drygalski.

MATHEMATICAL GEOGRAPHY.

Geodesy—Gravity observations. **Rosén.**

Bihang K. Svenska Vet. A.-Handlingar **20** (1895): 1-34.

Untersuchungen über die Schwere in der Grube Sala im Jahre 1890. Von P. G. Rosén.

Navigation. *Ann. Hydrographiques* (2) **17** (1895): 113–158. **Guyou.**

Les Problèmes de navigation et la carte marine. Par M. E. Guyou, Capitaine de Frégate.

Photographic Surveying. *Rev. Maritime et Colon.* **127** (1895): 459–465. **Thoulet.**

De l'emploi de la photographie en océanographie. Par M. J. Thoulet.

A paper read to the Sixth International Geographical Congress.

Position at Sea. *Rev. Maritime et Colon.* **127** (1895): 449–458. **Ripol.**

Calcul rigoureux du point à la mer par deux hauteurs quelconques. Par M. J. Ripol.

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Climatology. **Black.**

Summer Meteorology—Seaside, with Diagrams. By W. G. Black. Excerpt from vol. x. of the *Transactions* of the Sanitary Institute [1889]. Size 8½ × 6, pp. 16. *Presented by the Author.*

Configuration of Earth. **Lubbock.**

On the General Configuration of the Earth's Surface. By Sir John Lubbock, Bart. From the *Geographical Journal* for December, 1895. Size 10 × 6½, pp. 4.

Geomorphology—Ocean-basins. *C.R.* **121** (1895): 1113–1116. **Suess.**

Note sur l'histoire des océans. Par M. Suess.

This will be specially referred to in the Monthly Record.

Ice Motion. *J. Geology* **3** (1895): 918–934. **Case.**

Experiments in Ice Motion. By E. C. Case. *With Illustrations.*

Limnology—Lake Temperature. **Hergesell.**

Beobachtungen über die Lage der Sprungschicht der Temperatur im Weissen See bei Urbeis. Von H. Hergesell.—Geographische Abhandlungen aus den Reichslanden Elsass-Lothringen . . . herausgegeben von Prof. Dr. G. Gerland, Zweites Heft. Pp. 383–388. Stuttgart: E. Schweizerbart, 1895. Size 9½ × 6. *Plate.*

Physiography. *Educational Rev.* **10** (1895): 352–363. **Redway.**

What is Physiography? By J. W. Redway.

Mr. Redway finds that "Properly, physical geography includes only the description and distribution of landscape and surface features. Physiography, on the other hand, treats of the Science of Earth-sculpture viewed in the light of systematic processes."

Plant Distribution. *Knowledge* **19** (1896): 25–26. **Hemsley.**

Some curious facts in Plant Distribution. By W. Botting Hemsley.

Submarine Peaks. *American J. Sci.* (4) **1** (1896): 15–17. **Littlehales.**

The Form of Isolated Submarine Peaks. By G. W. Littlehales, U.S. Hydrographic Office.

This will be referred to in the Monthly Record.

Terrestrial Magnetism. **Schmidt.**

Erdmagnetismus und Erdgestalt. Von Dr. A. Schmidt.—Beiträge zur Geophysik . . . Herausgegeben von Prof. Dr. Georg Gerland. II. Band. 2–4. Heft. P. 197–210. Stuttgart: E. Schweizerbart, 1895. Size 9½ × 6. *Presented by the Publisher.*

ANTHROPOGEOGRAPHY AND HISTORY.

Chinese Studies. **Cordier.**

Fragments d'une Histoire des Études Chinoises au XVII^e^ siècle. Par Henri Cordier. Extrait du *Centenaire de l'École des langues orientales vivantes.* Paris: Imp. Nationale, 1895. Size 13 × 10, pp. 76. *Plates.*

Commercial Geography. **Ganeval and Groffier.**

Dictionnaire de Géographie Commerciale contenant sur les Marchés et Pays Commerçants du Globe, tous les Renseignements utiles aux Négociants et Industriels, etc., etc., suivi de 8 Cartes géographiques . . . Commencé par M. J.-A. Ganeval, continué par M. Valérien Philibert Groffier. Paris: C. Delagrave, 1895. Size 13 × 10, pp. x. and 800.

This is a Gazetteer of places of commercial importance, in which special prominence is given to local conditions directly affecting trade, such as tariffs, manufactures, means of communication, and markets.

Domestication of Animals. **Hahn.**

Die Haustiere und ihre Beziehungen zur Wirtschaft des Menschen. Eine geographische Studie, von Eduard Hahn. Leipzig: Duncker and Humblot, 1896 [1895]. Size 10 × 6½, pp. x. and 582. *Map. Presented by the Publisher.*

This book will be referred to in the Monthly Record.

Ethnology. **Keane.**

Ethnology. In two parts—I. Fundamental Ethnical Problems. II., the Primary Ethnical Groups. By A. H. Keane. Cambridge: The University Press, 1896.

Size 8 × 6, pp. xxx. and 442. *Illustrations. Price* 10*s.* 6*d. Presented by the Cambridge University Press.*

This volume will be specially noticed.

Historical—Columbus Letters. **Curtis.**

Field Columbian Museum. Publication 2. Vol. i. No. 2. The Authentic Letters of Columbus. By William Eleroy Curtis. Chicago, 1895. Size 10 × 6½, pp. [106]. *Facsimiles. Presented by the Director of the Field Columbian Museum.*

Jewish History. **Graetz.**

History of the Jews from the earliest times to the present day. By Professor H. Graetz. Specially Revised for this English Edition by the Author. Edited and in part translated by Bella Löwy. 5 vols. London: D. Nutt, 1891-1892. Size 9 × 6, pp. (vol. i.) xvi. and 552, (vol. ii.) xii. and 644, (vol. iii.) xii. and 672, (vol. iv.), xii. and 752, (vol. v.) xii. and 836. *Portrait. Presented by F. D. Mocatta, Esq.*

Man in the Tropics. *G.Z.* **2** (1896): 25–34. **Däubler.**

Acclimatisation und Physiologie der Tropenbewohner. Von Dr. K. Däubler.

This will be noticed in the Monthly Record.

Mediæval Geography. *J.R. Asiatic S.* (1896): 57–82. **Hirth.**

Chao Ju-kua, a new source of Mediæval Geography. By F. Hirth, PH.D.

Chao Ju-kua was a Chinese author of the beginning of the thirteenth century, who wrote a 'Record of Foreign Countries,' which Dr. Hirth translates and annotates.

Migrations. *G.Z.* **1** (1895): 649–665. **Hirt.**

Die Urheimat und die Wanderungen der Indogermanen. Von Dr. Herman Hirt in Leipzig-Gohlis.

The author inclines to the North-European origin of the Indo-Germanic or Aryan race.

Towns. *G.Z.* **1** (1895): 676–678. **Schneider.**

Stadtumfänge in Altertum und Gegenwart. Von Arthur Schneider. *With Plate.*

A comparison of the areas occupied by the cities of Babylon, Carthage, Syracuse, Alexandria, Rome, Ephesus, Athens, Thebes, Tarentum, Sparta, Tyre, and Jerusalem in ancient times, and of Berlin and Vienna in the seventeenth century and now.

BIOGRAPHY.

Berchert. *Deutsche Rundschau G.* **18** (1896): 183–186. **Miessler.**

Oskar Borchert. Von Adolf Miessler. *With Portrait.*

Cowan. *Deutsche Rundschau G.* **18** (1895): 85–87. **Miessler.**

M. D. Cowan. Von Adolf Miessler. *With Portrait.*

Biography of a Madagascar missionary.

Drake. *Deutsche Rundschau G.*, **18** (1896): 182–183. ——

Sir Francis Drake. *With Portrait.*

French Explorers. *Rev. Française* **20** (1895): 724–731. ——

Nos explorateurs Africains. Par A. M. *With Portraits.*

Contains notices and portraits of Paul Crampel, Albert Nebout, Jean Dybowski, Casimir Maistre, and L. Mizon.

Gill. *Scientific African* **1** (1896): 35–38. ——

David Gill. *With Portrait.*

Gruner. *Deutsche Rundschau G.* **18** (1895): 37–40. ——

Dr. Hans Gruner, der Leiter der deutschen Togo-hinterland-Expedition. *With Portrait.*

Lesseps. *B.S. normande G.* **17** (1895): 77–115. **Gravier.**

Ferdinand de Lesseps. Par Gabriel Gravier.

Lóczy. *Deutsche Rundschau G.* **18** (1895): 133–136. **Palóczy.**

Professor Ludwig v. Lóczy. Von Professor Leopold Palóczy. *With Portrait.*

Thomson. *Deutsche Rundschau G.* **18** (1895): 40–41. **Wolkenhauer.**

Joseph Thomson. Von W. Wolkenhauer. *With Portrait.*

Willkomm. *Deutsche Rundschau G.* **18** (1895): 137–138. ——

Professor Dr. Moriz Willkomm. *With Portrait.*

GENERAL.

Art of Travel. *Nouv. Archives Mis. Sci.* **6** (1895): 1-301. **Filhol.**

Conseils aux voyageurs naturalistes. Par M. H. Filhol. (Publication consécutive aux leçons faites au Museum d'histoire naturelle en 1893.)

This will be referred to in the Monthly Record.

British Association Report.

Report of the Sixty-fifth Meeting of the British Association for the Advancement of Science, held at Ipswich in September, 1895. London: John Murray, 1895. Size 9 × 6, pp. cxii., 884, and 118. *Diagrams, etc. Presented by the Association.*

British Empire. *Nineteenth Century* (1896): 218-235. **Wilson.**

The Protection of our Commerce in War. By H. W. Wilson.

Classification of Geography. *G.Z.* **2** (1896): 35-45. **Neumann.**

Die methodischen Fragen in der Geographie. Von Professor Dr. L. Neumann.

Educational. **Lyde.**

Man on the Earth, a course in Geography. By Lionel W. Lyde. London: Blackie & Son, 1895. Size 7½ × 5, pp. 192. *Illustrations. Price* 2*s. Presented by the Publishers.*

A series of nine short chapters dealing with as many separate aspects of geography in a very popular and simple form. It should be useful in stimulating an interest in geography, but requires to be accompanied by systematic teaching. The illustrations are numerous and representative, though varying a good deal in accuracy.

Geographical Principles. *Ann. G.* **5** (1896): 129-142. **De la Blache.**

Le principe de la géographie générale. Par M. P. Vidal de la Blache.

The author traces the evolution of the conception that the Earth must be treated in Geography as a whole, of which all the parts are co-ordinated.

Geographical Year-Book. **Wagner.**

Geographisches Jahrbuch. XVIII. Band, 1895. . . . herausgegeben von Hermann Wagner. Gotha: Justus Perthes, 1895. Size 6 × 9, pp. viii. and 486.

The new volume of this Year-Book deals in the usual thorough manner with six distinct departments of geography, each article the work of a competent specialist. The articles are as follows: Progress of Physics and Mechanics of the Earth, by Dr. H. Hergesell; Progress of the Physics of the Earth's Crust, by Dr. E. Rudolph; New Advances in the Geological Structure of the Earth's Surface (1892-94), by Dr. Franz Toula; the Progress of Oceanography (1893 and 1894), by Professor Krümmel; the Special Geography of extra-European Countries—Africa (1892-94), Australia, and Polynesia, by Professor Hahn; North America (1893 and 1894), by Dr. B. Weigand; Latin America (1892-93), by Dr. W. Sievers; Asia (excluding Russian possessions), by Dr. G. Wegener; Russian Asia, by Professor Anuchin; the History of Geography, by Professor Sophus Ruge; and the Progress of the Study of Geographical Names, by Professor J. J. Egli.

Geography. *Knowledge* **19** (1896): 1-4. **Mill.**

Geography as a Science in England. By Hugh Robert Mill, D.SC. Also a separate copy. *Presented by the Author.*

Suggests a memoir to the Ordnance Survey.

Legend of Barsisi. **Goldziher and Landberg-Hallberger.**

Die Legende vom Mönch Barṣîṣâ. Von Dr. Ign. Goldziher und Dr. C. Graf v. Landberg-Hallberger. Kirchhain N.-L., Max Schmersow vorm. Zahn & Baendel, 1896. Size 9½ × 6½, pp. 30.

Money. *J.R. Statistical S.* **58** (1895): 559-590. **Probyn.**

Gold and Silver and the Money of the World. By Lesley C. Probyn. With Discussion.

Contains tables of the gold and silver-using countries of the world.

Navigation. **Colomb.**

[Course of Papers (No. 40).] Shipmasters' Society, London. Seventh Session. Introductory Address, by Captain E. Blackmore. The Manœuvring Powers of Steamships and the Avoidance of Collisions. By Vice-Admiral P. H. Colomb. London: Pewtress & Co., 1895. Size 8½ × 5½, pp. 56. *Diagrams.*

Sixth International Geographical Congress. **Giglioli.**

Prof. E. H. Giglioli. Il VI. Congresso Geografico Internazionale. Lettera al march. Giacomo Doria, Presidente della Società Geografica italiana. Rome, 1895. Size 9 × 6, pp. 16. *Presented by the Author.*

Sixth International Geographical Congress. **Ricchieri.**

VI. Congresso Geografico Internazionale di Londra. [Prof. conte G. Ricchieri.] Estratto dal Bollettino della Società Geografica Italiana, Fasc. IX. 1895. Size 9 × 6, pp. 10.

Sugar-Producing Colonies. *J. R. Colonial I.* **27** (1896): 77–109. **Williams.**

The Future of our Sugar-producing Colonies. By Mr. Justice Condé Williams.

NEW MAPS.

By J. Coles, *Map Curator*, R.G.S.

EUROPE.

England and Wales. **Ordnance Survey.**

Publications since January 7, 1896.

1-inch—General Maps:—

ENGLAND AND WALES:—135, engraved in outline; 110, 111, 124, 135, 140, 154, 168, 169, hills photozincographed in brown; 205, 283, 287, 290, 320, 330, 331, 358 (revision), engraved in outline, 1*s.* each.

IRELAND:—168, 146, hills shaded, 1*s.* each.

25 inch—Parish Maps:—

ENGLAND AND WALES:—**Berkshire** (revised), XLIA. 3; XLIV. 7, 8. **Durham** (revised), V. 8. **Hampshire** (revised), IV. 7, 8; VII. 3; IX. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; XV. 15, 16; XVI. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 13, 14, 15, 16; XVII. 2, 3, 5, 9; XXIV. 1, 3, 4, 5, 6, 8, 9, 11, 12; XXV. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12. **Hertfordshire** (revised), XL. 7, 16; XLIII. 15, 16; XLIV. 8, 11, 12, 14. **Kent** (revised), XXVIII. 12, 15, 16. **Middlesex** (revised), I. 7, 11, 16; IV. 15, 16; V. 8, 11, 12, 14; IX. 4; X. 1, 13; XIV. 4, 8, 12, 16; XV. 2, 5, 9; XIX. 4. **Surrey** (revised), XVIII. 10, 11, 13, 14, 16; XIX. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. **Wiltshire** (revised), XLIII. 3, 3*s.* each. All the above are ruled.

Town Plans—10-feet scale:—

ENGLAND AND WALES:—**Newcastle, Gateshead, and Environs** (revised), 1, 2, 3, 4, 6, 7, 8, 10, 11, 13, 15, 110, 115, 116, 118, 123, 125, 129, 130, 131, 135, 139, 2*s.* 6*d.* each. **Tynemouth, North and South Shields** (revised), IV. 2, 96, 2*s.* 6*d.* Index not yet published. **Croydon** (revised), XIV. 6, 8, 9, 12, 13, 14, 16, 18, 21, 22, 23, 24; XIV. 10, 2, 3, 4, 8, 11, 12, 13, 16, 21, 22, 2*s.* 6*d.* each. Index, 4*d.*

——— 5-feet scale:—

London—Re-survey, II. 98; III. 24, 43, 52, 53, 54, 62, 63, 65, 74, 75; VI. 59; VII. 12, 17, 23, 27, 28, 32, 37, 49, 50, 59, 60, 62, 69, 70, 73, 79; X. 61; XI. 29, 30, 35, 46, 49, 65, 68, 70, 96; XV. 7, 10, 17, 27, 28, 36, 37, 38, 47, 48, 54, 56, 57, 65, 66, 67, 77, 97; XVI. 43, 53; XVII. 16, 26, 45, 2*s.* 6*d.* each. Index, 3*d.*

(*E. Stanford, Agent.*)

England and Wales. **Geological Survey.**

Geological Survey of England and Wales. Index Map. Scale 1: 253,440 or 4 stat. miles to an inch. Sheet 12. *Price* 2*s.* 6*d.* *Presented by the Director of the Geological Survey.*

This is the first sheet issued by the Geological Survey Office that has been printed in colours, the object in view being to reduce the cost of production so as to place the valuable results of the Geological Survey within the reach of all. The previously issued sheets of this department, having been coloured by hand, are necessarily expensive, and some idea of the saving effected by printing the colours may be arrived at from the fact that the present sheet is sold at 2*s.* 6*d.*, that being less than a quarter of its price when hand-coloured. If this reduction in the cost of production had been made at the expense of accuracy, or even appearance, there would have been but little gained. This, however, is not the case, as the colours are delicate, and register well.

The area embraced in this sheet includes the east coast from Orford to Winchelsea, and extends west as far as Henley-on-Thames, London thus occupying a central position. The scale on which it is published is 4 miles to an inch, which is sufficiently large to be useful to students, or tourists interested in geology. It is understood that the present issue of this sheet at so largely reduced a price is an experiment; but that, if it meets with a ready sale, the Stationery Office will probably be encouraged to publish the rest of the sheets of the map coloured in the same manner.

England and Wales. **Longmans.**

Relief Map of England and Wales. Longmans & Co., London and New York. Mounted on rollers. *Price* 4*s.* 6*d.* *Presented by the Publishers.*

ASIA.

Armenia. **Supan.**

Verteilung der Armenischen Bevölkerung in Türkisch-Armenien, Kurdistan u. Transkaukasien. Nach Cuinet, Selenoy und v. Seydlitz entworfen von A. Supan. Scale 1 : 3,700,000 or 58·4 stat. miles to an inch. Petermann's 'Geographische Mitteilungen,' Jahrgang 1896, Tafel 1. Gotha: Justus Perthes. *Presented by the Publisher.*

Armenia. **Johnston.**

Map to illustrate the Armenian Question in Asia Minor. Scale 1 : 6,652,000 or 105 stat. miles to an inch. W. & A. K. Johnston, Edinburgh and London, 1895. *Price* 1*s.* *Presented by the Publishers.*

AFRICA.

Central and South Africa. **Bartholomew.**

Bartholomew's New Map of Central and South Africa. Scale 1 : 5,600,000 or 88·3 stat. miles to an inch. Edinburgh: J. Bartholomew & Co. *Price* 3*s. mounted.* *Presented by the Publishers.*

In the compilation of this map the most recent material has been used to bring it up to date.

Congo. **Wauters.**

Carte des 200 premiers Kilomètres du Chemin de fer du Congo à l'échelle du 1 : 100,000 or 1·5 stat. mile to an inch. Dressée par A. J. Wauters, Secrétaire général de la Compagnie du Chemin de fer du Congo. Bruxelles: Administration du Mouvement Géographique, 1895.

Transvaal. **Johnston.**

Map of the Transvaal or South African Republic and Surrounding Countries. Scale 1 : 3,801,600 or 60 stat. miles to an inch. W. & A. K. Johnston, London and Edinburgh, 1896. *Price* 1*s.* *Presented by the Publishers.*

AMERICA.

British Columbia. **Martin.**

Map of the Province of British Columbia. Compiled by direction of the Hon. G. B. Martin, Chief Commissioner of Lands and Works. Victoria, B.C., 1895. Scale 1 : 1,124,200 or 18 stat. miles to an inch. Sabiston Lithographing and Publishing Co., Montreal. 2 sheets.

British Columbia. **Boas.**

Sprachenkarte von Britisch-Columbien. Von Franz Boaz. Scale 1 : 7,500,000 or 118·3 stat. miles to an inch. Petermann's 'Geographische Mitteilungen,' Jahrgang 1896, Tafel 2. Gotha: Justus Perthes. *Presented by the Publisher.*

Venezuela—British Guiana Boundary. **Stanford.**

Stanford's Map of Guiana and Venezuela, showing the Territorial Claims of Britain and Venezuela, France, and Brazil. Scale 1 : 5,274,720 or 83·25 stat. miles to an inch. London: E. Stanford.

Venezuela—Guiana Boundary. **Philip.**

Special Map of British Guiana illustrating the Venezuela-Guiana Boundary Dispute, 1895–6. Scale 1 : 2,217,600 or 35 stat. miles to an inch. G. Philip & Son, London. *Price* 1*s.* *Presented by the Publishers.*

GENERAL.

Exploration. **Schrader.**

l'Année Cartographique. Supplément Annual à toutes les publications de Géographie et de Cartographie. Dressé et rédigé sous la direction de F. Schrader, directeur des travaux cartographiques de la librairie Hachette et Cie. Cinquième Supplement, contenant les modifications géographiques et politiques de l'Année, 1894. Trois feuilles de Cartes avec texte explicatif au dos. Paris: Librairie Hachette et Cie. *Price* 3 *fr.*

The first sheet contains a map of Central Asia, on which the route of Mr. Dutreuil de Rhins and Mr. F. Grenard (1891–94) is laid down; it also contains maps showing the Anglo-Chinese boundary between Burma and Yunnan, the route of Lieut. Debary from Tourane to Muong-Cao, the route surveys of Lieuts. von Prittwitz, Gaffron, and von Flottwell (1893) in Asia Minor, and Mr. H. Lake's work in Malacca, 1893. The second sheet contains maps illustrating the principal recent explorations in Africa, including Graf von Götzen's remarkable journey (1894). The third sheet contains maps of different parts of South America, in which explorations have been recently made. The maps are accompanied by explanatory notes, which are printed on the back of each map.

Globes. **Philip**

Eight small Globes exhibiting the world in accordance with the ideas of Eratosthenes, 220 B.C.; Ptolemy, 150 A.D.; Behaim, 1492; Ruysch, 1508; Leonardo da Vinci, 1515; Schöner, 1515; Oronce Finé, 1531; and Mercator, 1569. G. Philip & Son, London.

This set of globes, which was exhibited at the meeting of the International Geographical Congress held in London last year, has been added to the collection, and can now be seen in the Society's Map-room. The conceptions of ancient geographers have been drawn on globes, which show, in faint outline, the correct delineation of the geographical features, and thus enable a comparison to be readily made.

The World. **Schrader.**

Atlas Universel de Géographie construit d'après les sources originales et les documents les plus récents cartes, voyages, mémoires, travaux géodésiques, etc.; avec un Texte analytique. Ouvrage commencé par M. Vivien de Saint-Martin et continué par Fr. Schrader. No. 77. Amérique du Sud en 5 feuilles. Feuille Nord-Ouest. Paris: Librairie Hachette et Cie.

This sheet, which forms part of a large map of South America, contains the whole of Columbia and Ecuador, the greater part of Venezuela, and part of the Brazilian province of Amazonas. The authorities used in the compilation of this map are named in the accompanying letterpress.

Like all the maps in this atlas, the style in which it is produced leaves nothing to be desired; but the number of years which has elapsed since their publication commenced is much to be regretted.

CHARTS.

Admiralty Charts. **Hydrographic Department, Admiralty.**

Charts and Plans published by the Hydrographic Department, Admiralty, during November and December, 1895. *Presented by the Hydrographic Department, Admiralty.*

No.	Inches.	
1967	m = 12·0	England, south coast:—Plymouth sound. 2*s.* 6*d.*
676	m = 0·1	Mediterranean:—Tyrrhenian sea. 2*s.* 6*d.*
2001	m = 5·0 m = 18·0	South America, east coast:—Monte Video bay, Approach to Cibil dock. 1*s.* 6*d.*
660	m = 3·9	Central America, west coast:—Corinto harbour (port Realejo). 1*s.*
1369	m = 10·0	Africa, west coast:—Sketch of Brass river and creeks. 1*s.*
708	m = 0·5 m = 2·0 m = 0·95	Anchorages on the west coast of Madagascar:—Minow islands, Diamond bay, Boyanna bay. 1*s.* 6*d.*
378	m = 1·0	Madagascar, north-west coast:—Maromanjo point to Makambytra bay, including Bombetoke bay. 2*s.* 6*d.*
575	m = 0·23 m = 6·0	Bay of Bengal, Coromandel coast:—Madras to Ramiapatam (plan, Madras roadstead). 2*s.* 6*d.*
2687		Little Bras d'or lake, and St. Anne and Sydney harbours:—Plan added, Baddeck harbour.
1109		Harbours and anchorages in the Red sea:—Plan added, Melita bay.

(*J. D. Potter, Agent.*)

Charts Cancelled.

No.	Cancelled by	No.
2001 Monte Video bay.	New Chart. Monte Video bay. Approach to Cibil dock	2001
1927 Plan of Corinto harbour on this sheet.	New Chart. Corinto harbour (port Realejo)	660
708 Minow islands with Diabay.	New Chart. Anchorages on the west coast of Madagascar:—Minow islands, Diamond bay, Boyanna bay	708
698 Boyanna bay.		
699 Makambytra.	New Chart. Maromanjo point to Makambytra bay, including Bombetoke bay	378
71c Coromandel coast, Sheet 3. From lat. 13° to lat. 15° (plan, Madras roadstead).	New Chart. Madras to Ramiapatam (plans, Madras roadstead)	575
302 Couteau bay to Cape Anguille.		

Charts that have received Important Corrections.

No. 2598, Curves of Equal Magnetic Variation. 240, England, south coast:—Hamoaze. 1451, Scotland, east coast:—Firth of Inverness and Beauly basin. 1479, Norway, west coast:—The Naze to the North Cape. 2298, Gulf of Bothnia:—Sheet 3, Nystad light to Stor fiörd. 2252, Baltic sea:—Gulf of Bothnia. 2664, France, west coast:—D'Arcachon point to De la Coubre point, including river Gironde to Bordeaux 438, France, north coast:—Cape d'Alprech to Ambleteuse, including Boulogne. 524, Mediterranean:—Gibraltar new mole. 1651, Nova Scotia:—Prince Edward island and part of New Brunswick. 2666, North America, east coast:—St. John's to Halifax. 2670, North America, east coast:—Halifax to the Delaware. 478, Puerto Rico:—Port San Juan, Port Arecibo. 146, Africa, west coast:—Niger river (Nun entrance), Brass river. 653, Africa, east coast:—Ports of Conducia, Mozambique, and Mocambo. 663, Africa, east coast:—Mansa and Tanga bays. 253A, Gulf of Aden:—Jebel Jan to Seyára. 164, Red sea:—Massawa channel, Port Smyth. 942B, Eastern Archipelago, eastern portion. 962, Ports in the Philippine islands. 1601, China, east coast:—Wusung river or Hwangpu, Wusung river entrance. 140, Japan:—West coast of Kiusiu, from Mats'sima to Atsusi No-O-Sima, including Hirado island and Goto islands. 135, Japan:—Sagitsu-no-ura, Tomari Ura, Kata Ura. 2432, Russian Tartary:—Lamen Ula to Strelok bay, including Peter the Great bay. 1418, Australia, south coast:—Princess Royal harbour. 1674, Australia, east coast:—Brisbane river. 447, Australia, north coast:—Western approaches to Torres strait. 939, New Guinea:—Cape Nelson to Hercules bay. 214, Pacific ocean:—Solomon islands (plans, Gazelle harbour and Gizo anchorage). 440, South Pacific:—Fiji islands; Eastern archipelago, northern portion. 1490, North Pacific ocean:—Harbours and anchorages in the Sandwich islands.

(*J. D. Potter, Agent.*)

PHOTOGRAPHS.

Asia Minor. **Munro, Anderson, and Anthony.**

Twenty-five Photographs of North-West Asia Minor, by Messrs. Munro, Anderson, and Anthony, 1894. *Presented by J. A. R. Munro, Esq.*

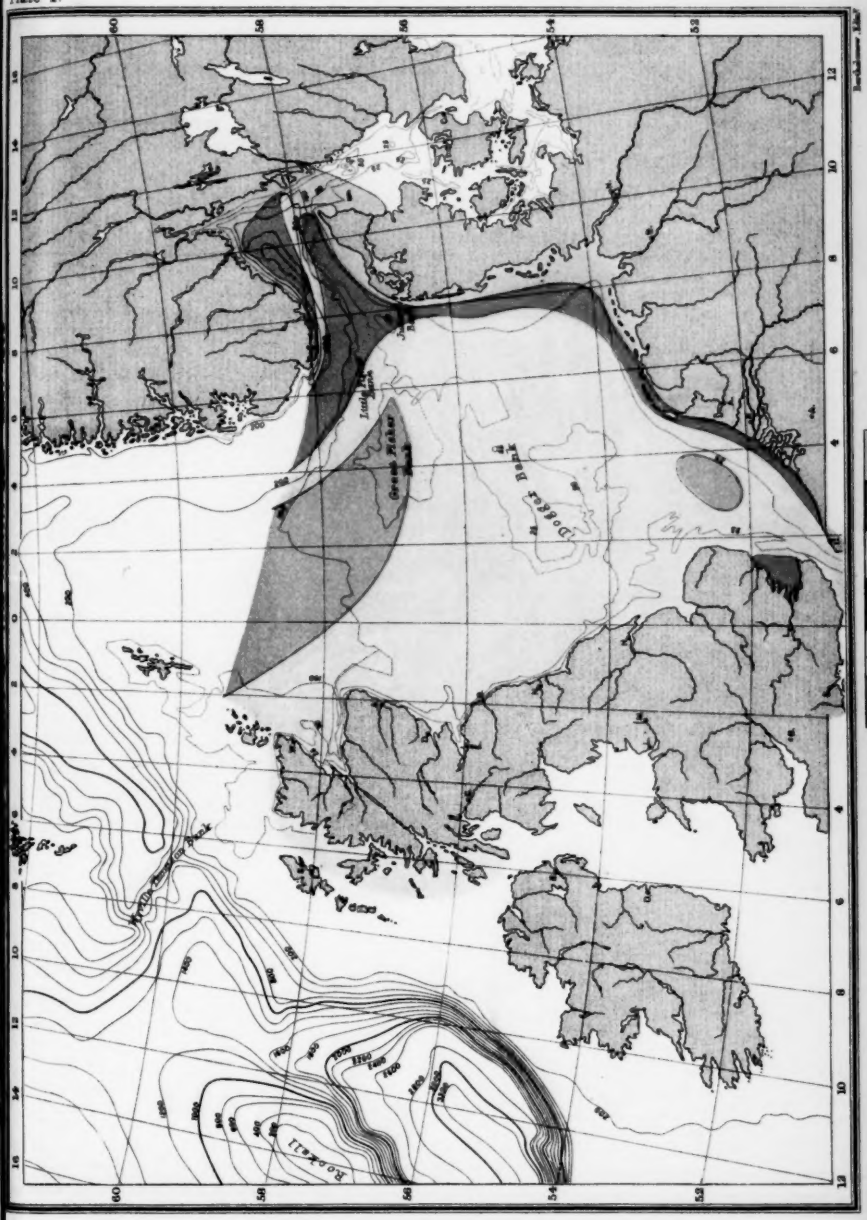
The photographs show the characteristic scenery of North-West Asia Minor, the dwellings of the people, and some of the antiquities. They form a valuable addition to the Society's collection.

Norway. **Mockler-Ferryman.**

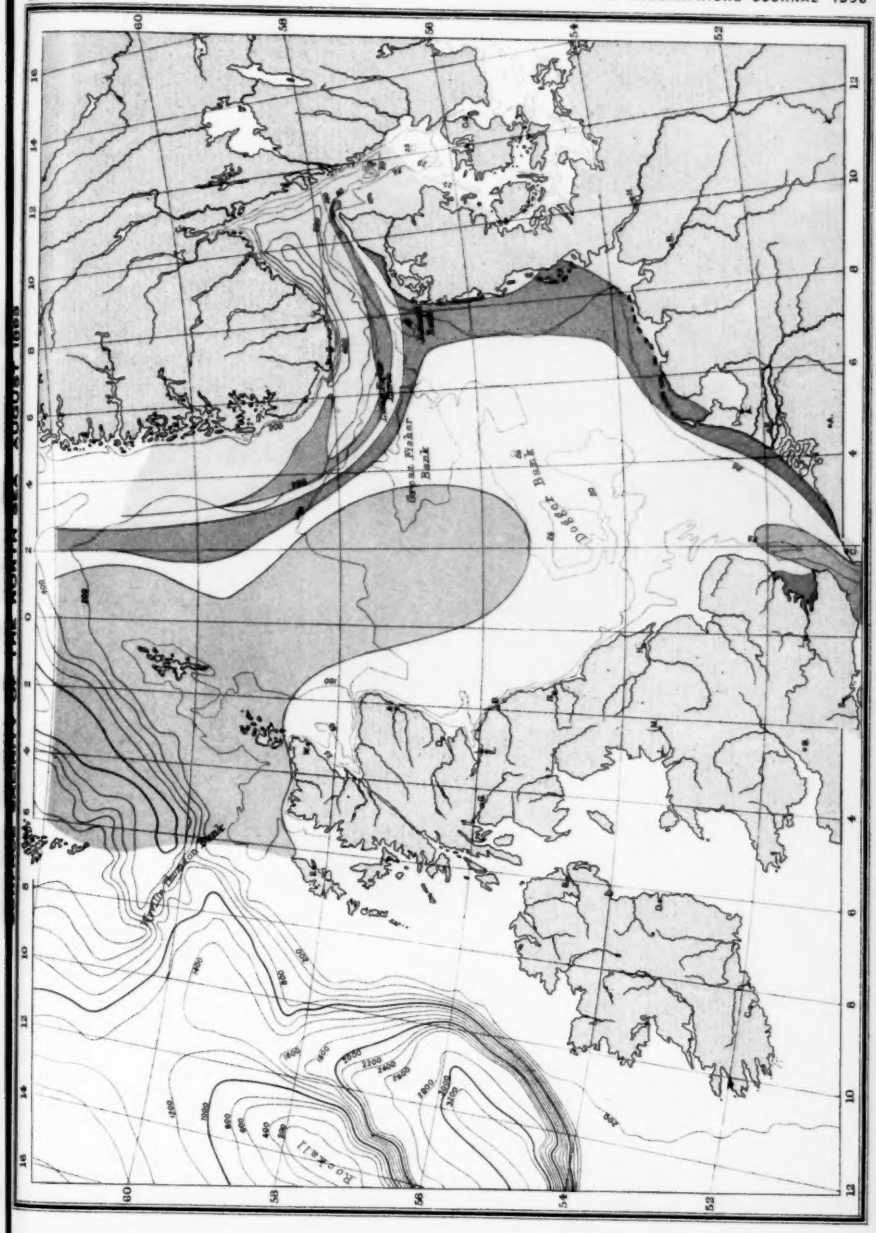
Seventeen Photographs of Norway, taken by Captain A. F. Mockler-Ferryman, in the autumn of 1895. *Presented by Captain A. F. Mockler-Ferryman.*

This series of photographs contains views of Norway taken in the Hardanger district, Telmarken, the Randsfjord river and lake, Laerdal, and a panorama of Vossevagen. The views are well chosen, and the photographs are remarkably good.

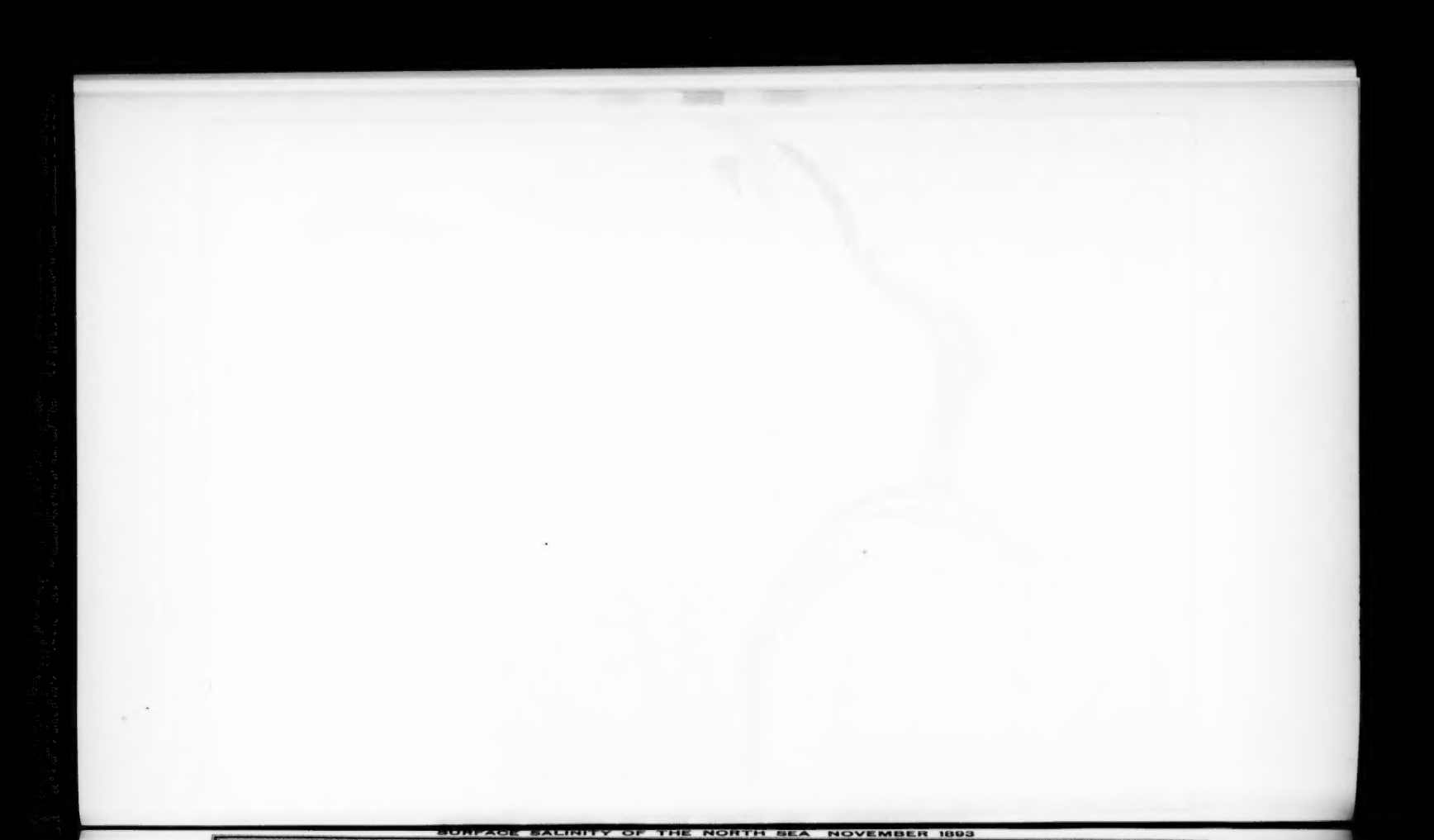
N.B.—It would greatly add to the value of the collection of Photographs which has been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.

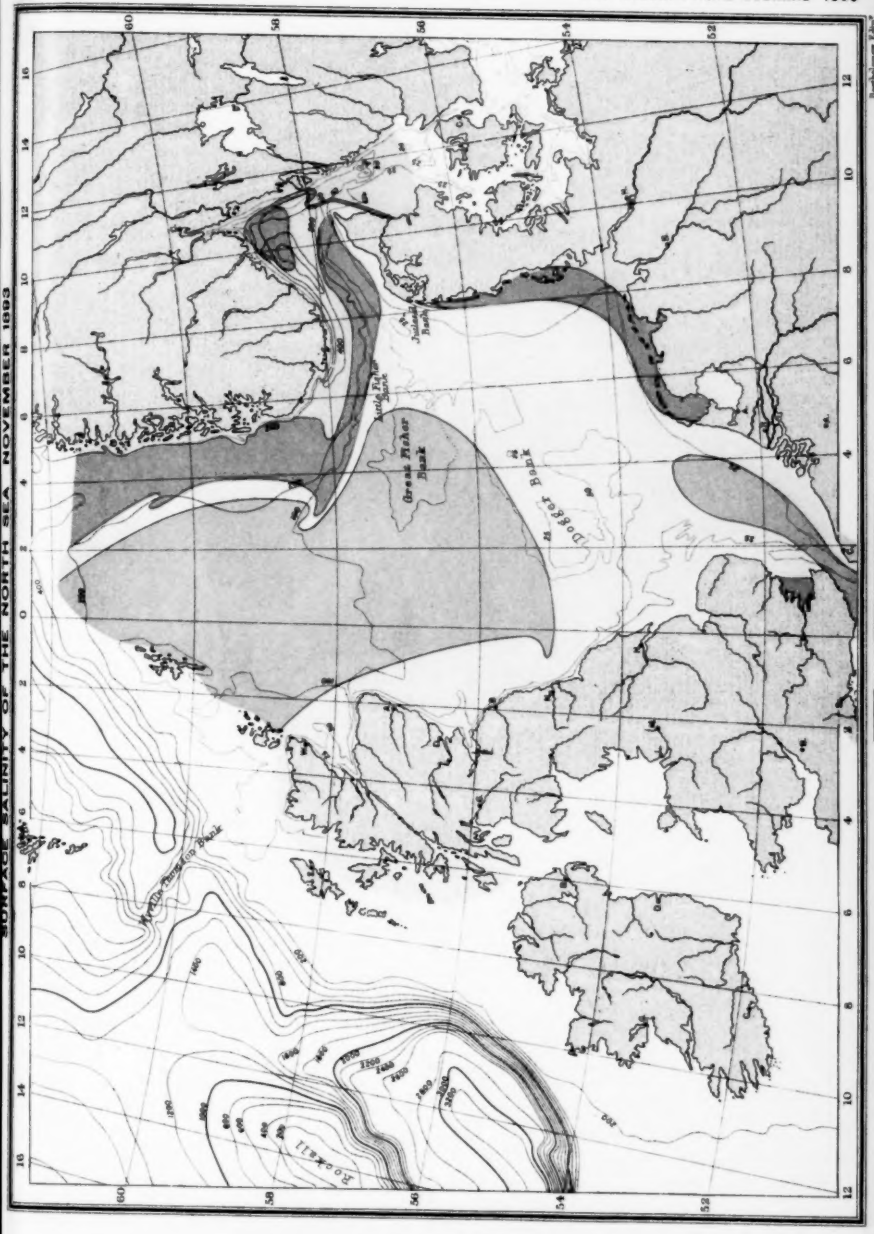


Published by the Royal Geographical Society.

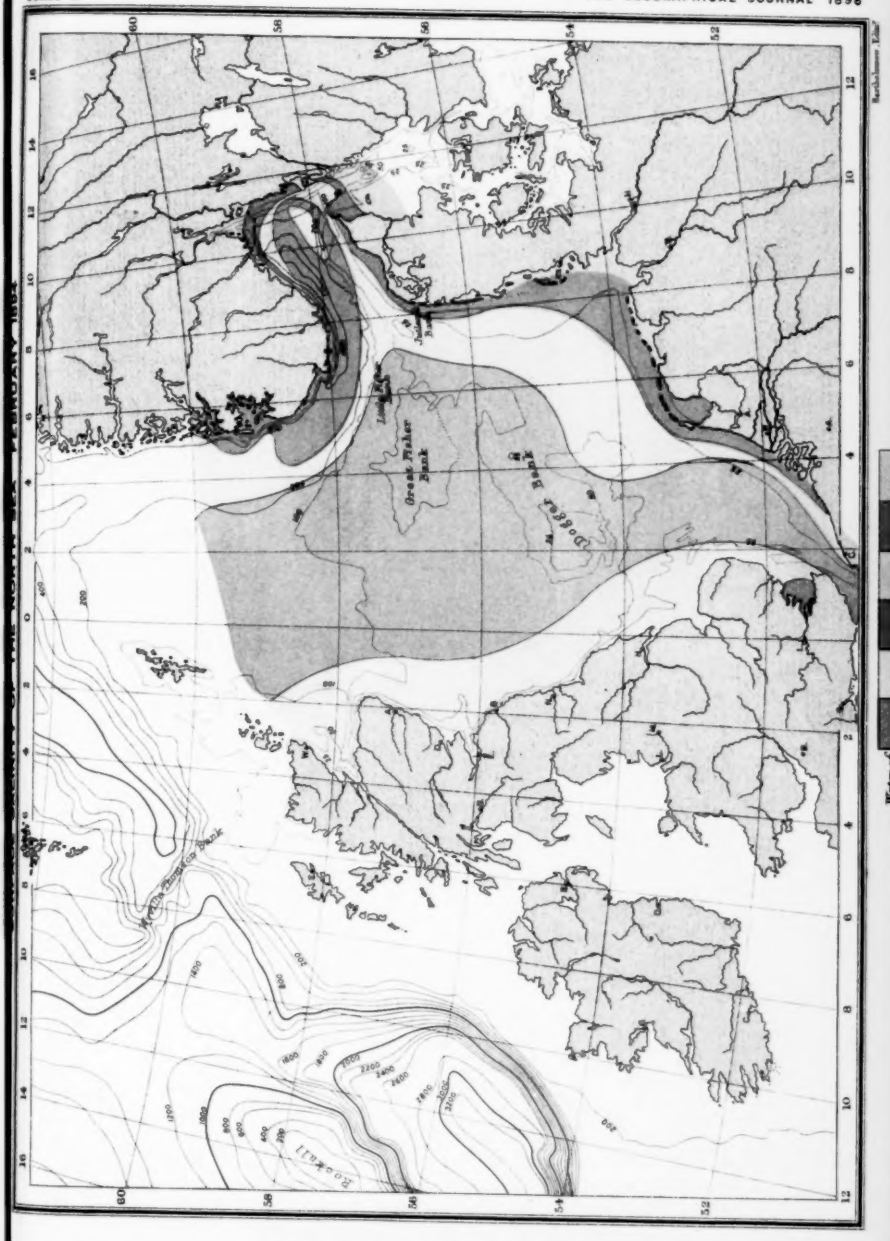


Published by the Royal Geographical Society.

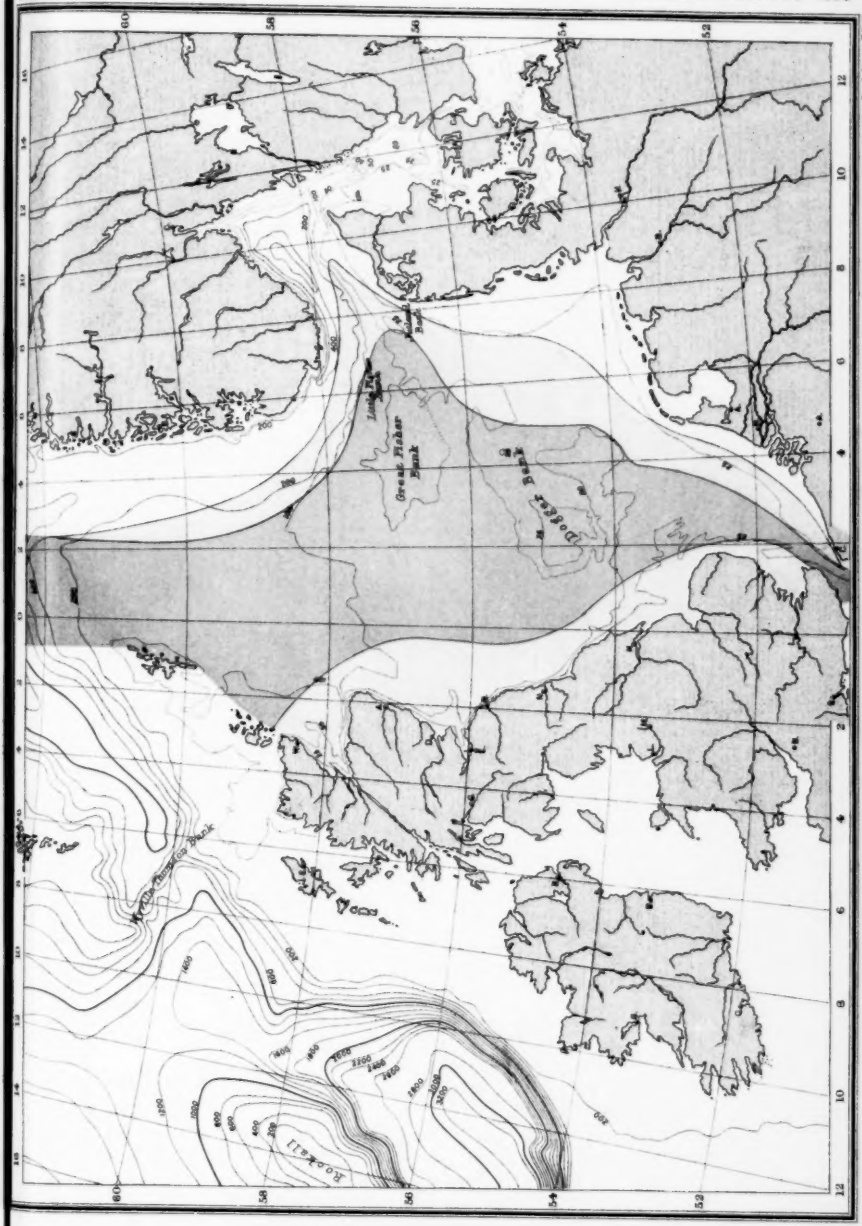

SURFACE SALINITY OF THE NORTH SEA NOVEMBER 1893



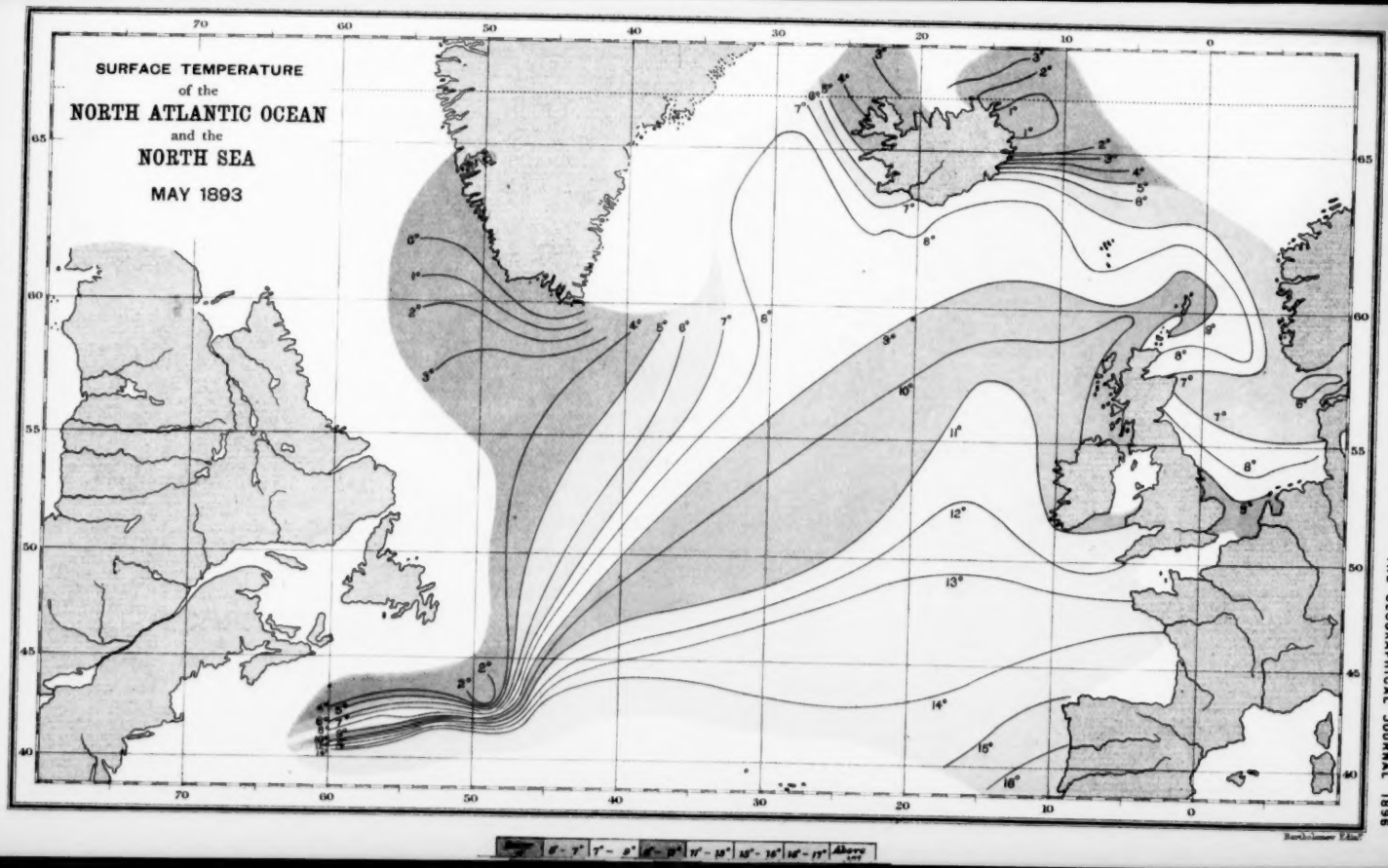
Published by the Royal Geographical Society.



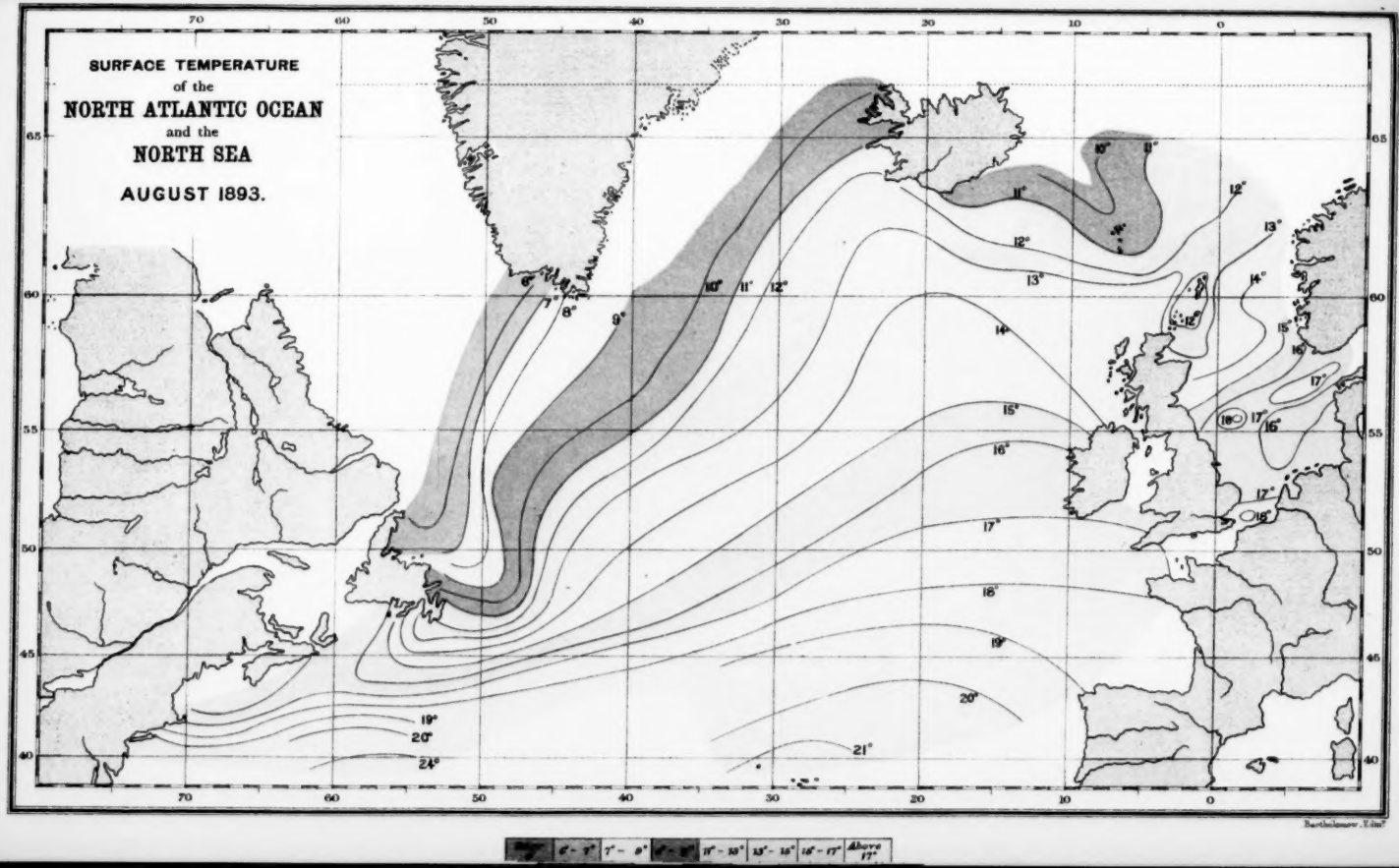
Published by the Royal Geographical Society.



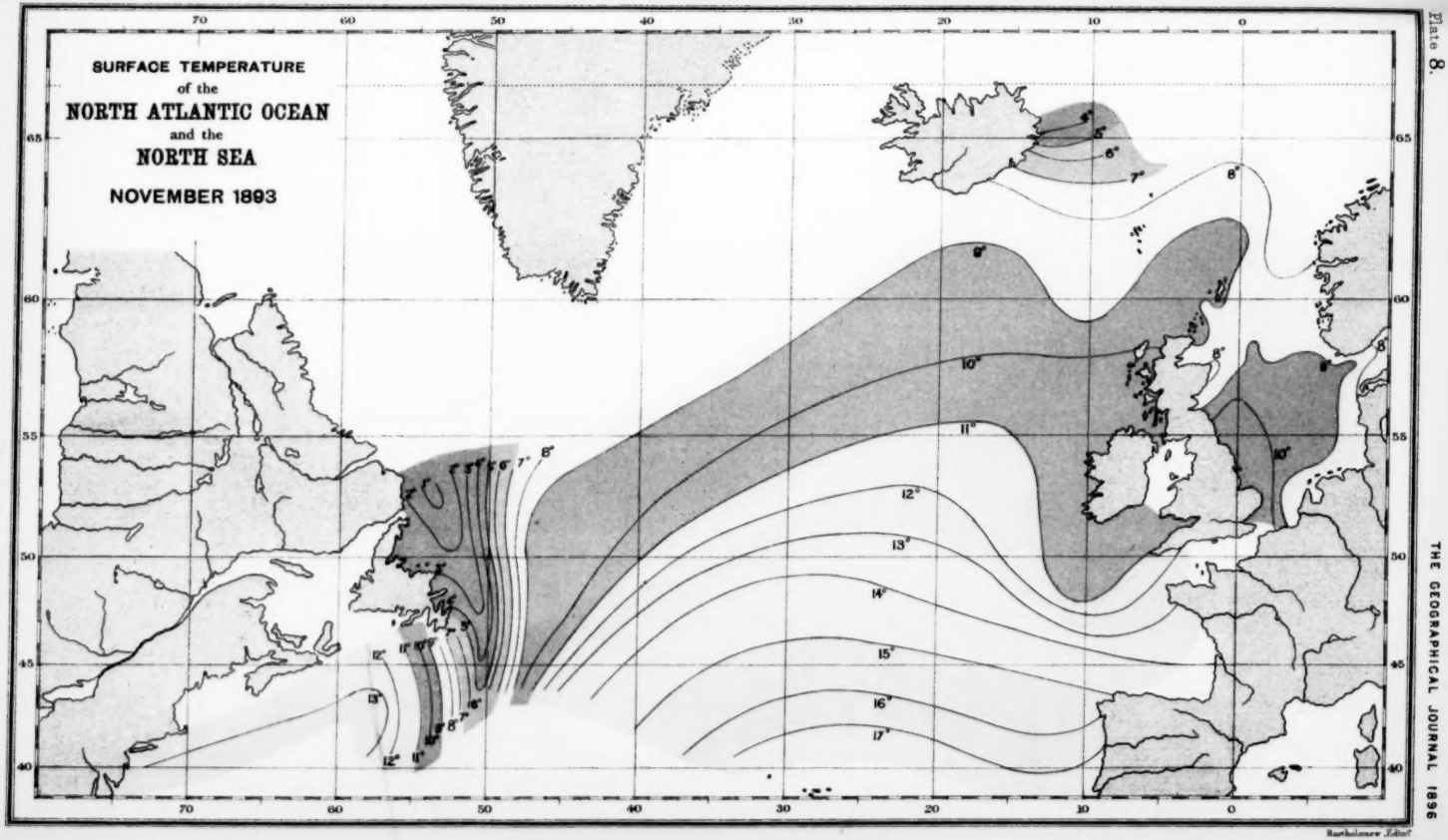
Published by the Royal Geographical Society.



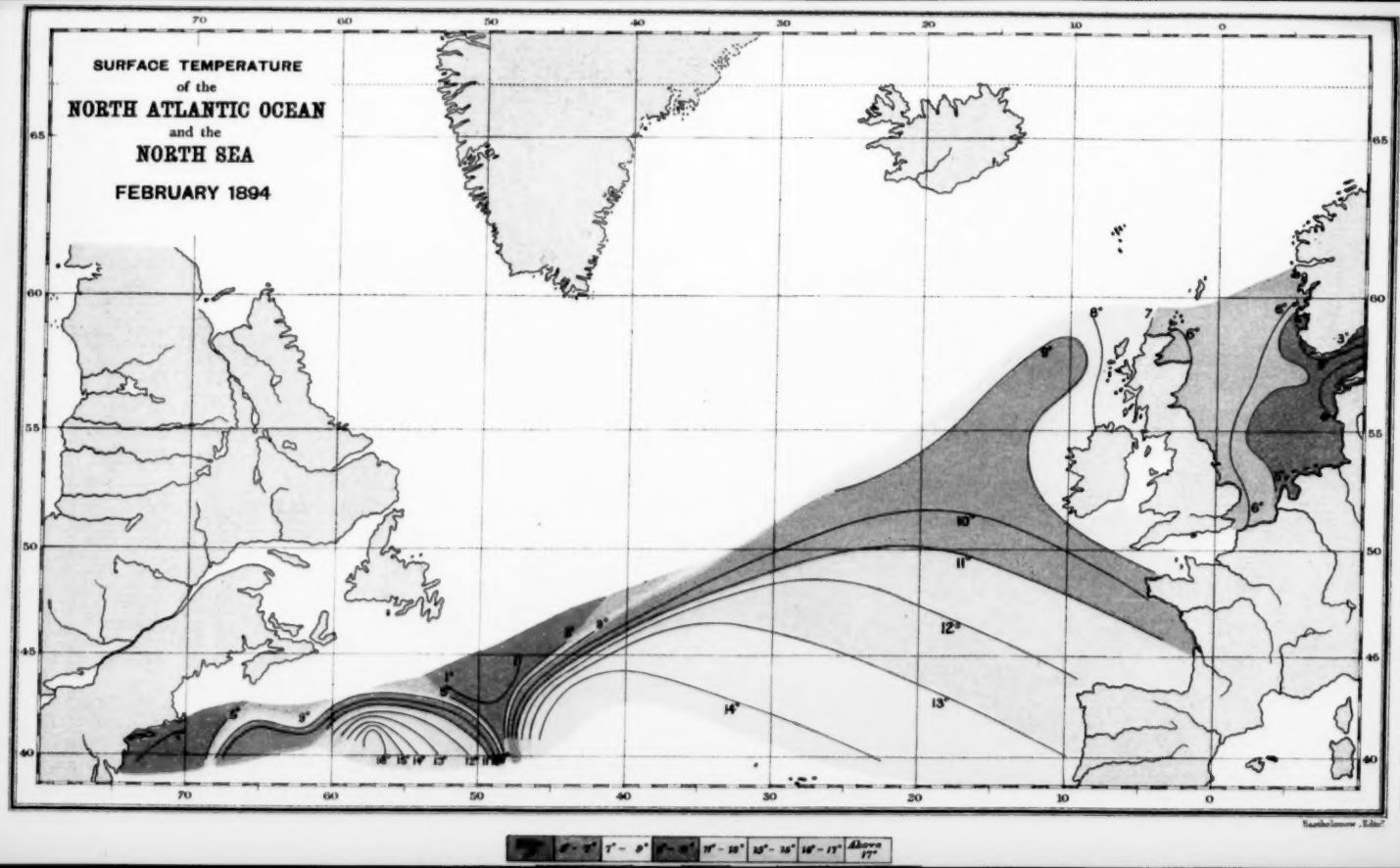
Published by the Royal Geographical Society.



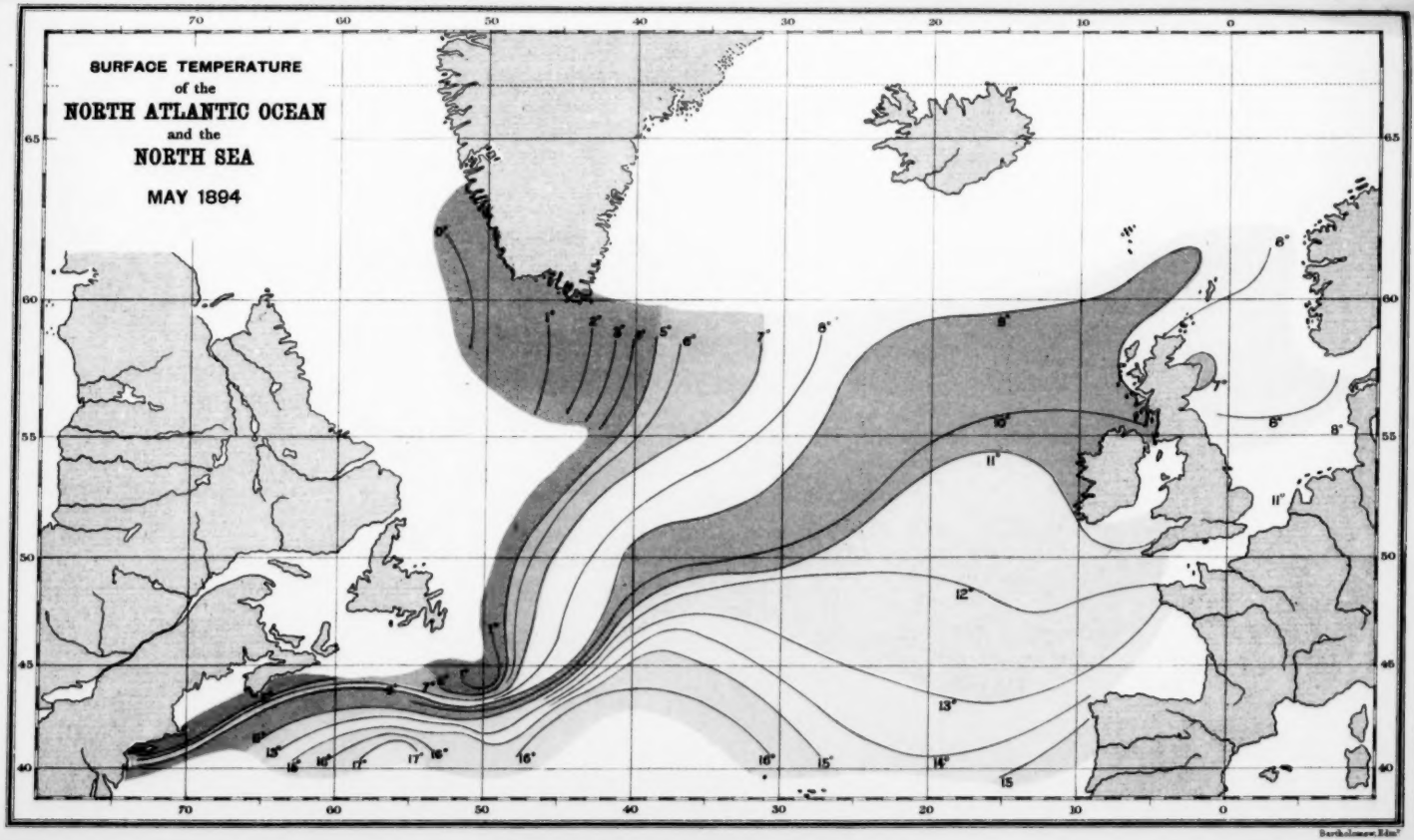
Published by the Royal Geographical Society.



Published by the Royal Geographical Society.



Published by the Royal Geographical Society.



Published by the Royal Geographical Society.

Published by the Royal Ge

W. & A.K. Johnston, Edinburgh & London

d by the Royal Geographical Society